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Remodel Small

Still only 850 sq. ft., this converted schoolhouse is a master class in good design PAGE 30

Framing big gable walls PAGE 42

Working with insulating sheathing PAGE 52

Installing trim on a curved wall PAGE 56

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FEATURES

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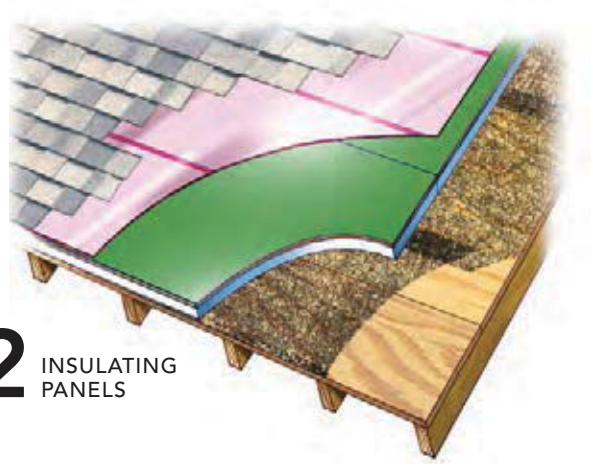
Cover photo by Rob Yagid



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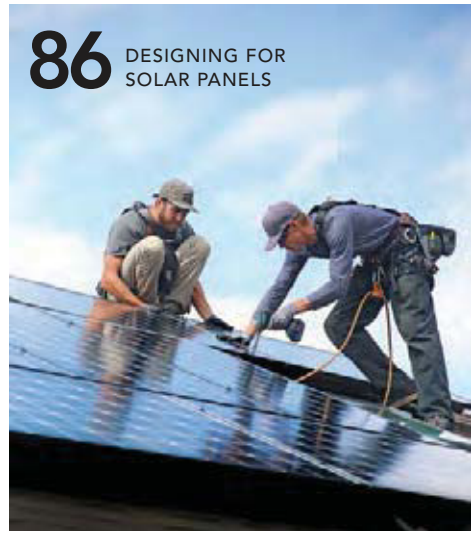

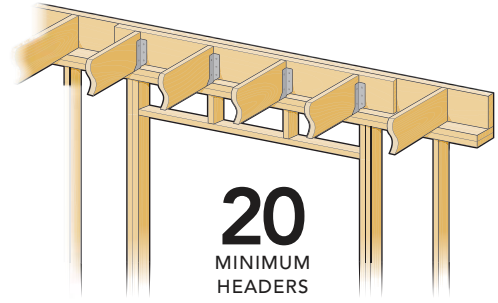

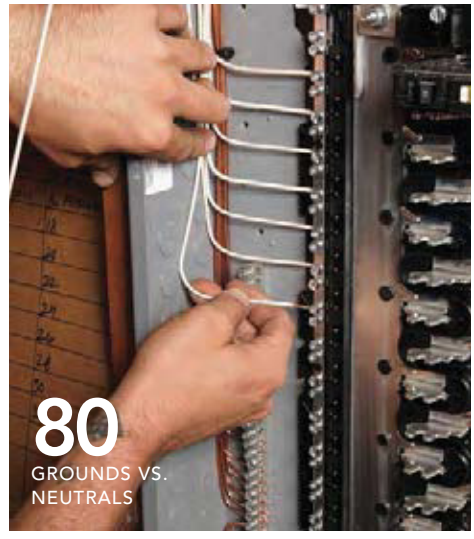

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Our new painting guide has more that 80 articles and dozens of videos full of expert advice to help you apply the perfect finish to any project.

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Fast and accurate wall framing

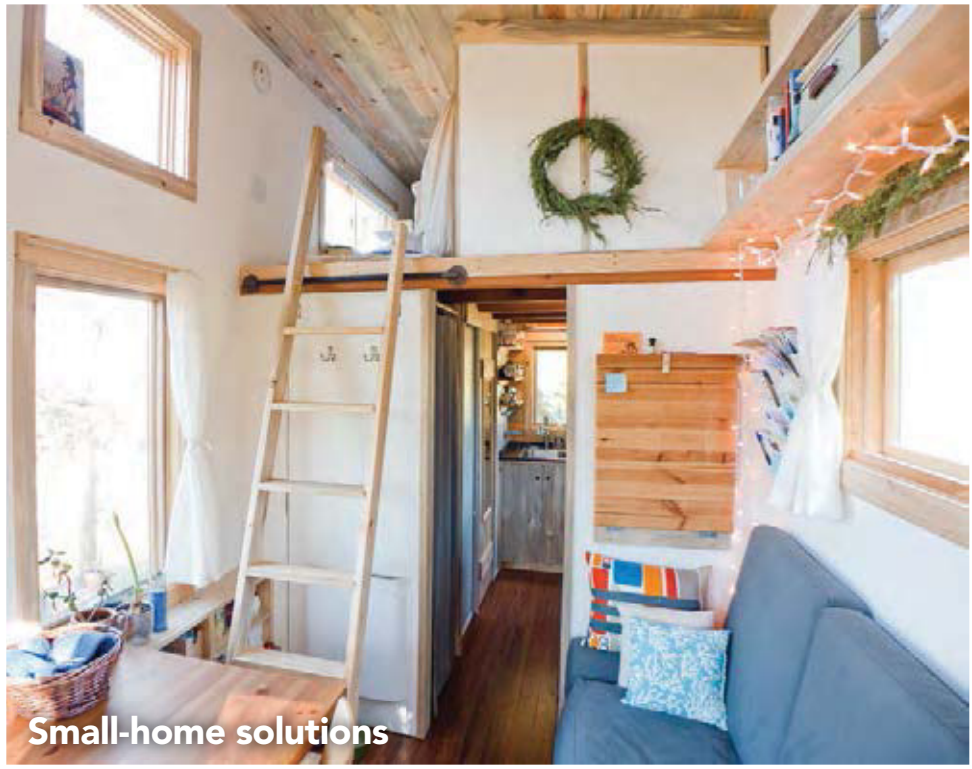
For wall layout and assembly tips, read about Tim Uhler's method (pp. 42-46), then watch the Master Carpenter video series by builder Mike Norton at FineHomebuilding.com/fastframing.

FHB

The Fine Homebuilding Podcast

Episode 269: Protecting workers

Matt, Rob, and Patrick discuss how tradespeople can get the respect they deserve, and what features they'd want in a high-performance home. Visit FineHomebuilding.com/podcast.



Small-home solutions

If you were inspired by the lessons Rob Yagid shared in "Schoolhouse Reimagined" on pp. 30-37, browse this collection of online resources to learn more about how to make the most of a small space: FineHomebuilding.com/downsize.

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THE VOICES OF EXPERIENCE

CLIFF POPEJOY (Tools & Gear, p. 26, and Ask the Experts, p. 84) is a licensed electrical contractor specializing in old-house wiring. He also has done residential, commercial, and studio/gallery lighting design and installation. Cliff is a long-time volunteer with Habitat for Humanity, training and leading a crew that wires both old and new houses. He's also taught wiring basics to at-risk youth in vocational education programs. He's written a book on wiring projects and has contributed to several books on house wiring and old houses.

ROB YAGID ("Schoolhouse Reimagined," pp. 30-37, and Keep Craft Alive, p. 90) spent over a decade at *Fine Homebuilding* magazine, serving as the editorial director of *FHB* and Green Building Advisor. He is the founder and current executive director of Keep Craft Alive, a program that supports the next generation of men and women pursuing opportunities in the trades. Rob also spearheads digital media for the fastest-growing conservation organization in North America, Backcountry Hunters & Anglers, based in Missoula, Mont.

Prior to forming Casco Bay Insulation in 2009, **JON RILEY** (Ask the Experts, pp. 82-84) was a HERS rater working with builders and homeowners to create durable, comfortable homes. A firm believer in the holistic "House as a System" approach, he continues to help builders and homeowners meet their comfort goals while keeping a close eye on moisture management and ventilation strategies. In this issue, Jon writes about safely removing fiberglass insulation in an attic, air-sealing, and reinsulating.

write an article

Fine Homebuilding welcomes articles from our readers. We'll acknowledge all proposals and return any we can't use, and we'll pay for any articles we publish. For details, check our website at FineHomebuilding.com.

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READER FEEDBACK

FROM THE EDITOR

Justin Fink, builder-at-large

With the immediacy of social media and podcasts, this may seem like old news. But given the time and dedication Justin Fink put into his work at *Fine Homebuilding* for the last 16 years, it is without a doubt an announcement that deserves its place in print. On August 1, Justin left his role at the magazine to devote more time to his own business, Fink & Son Carpentry and Woodworking. Though Fink & Son was established just this year, Justin has been tackling building and remodeling projects as a licensed Connecticut contractor for as long as he has been at *FHB*. Before we get to Justin's future, let's take a quick look at his history at the magazine.

Justin began his time at the magazine traveling the country to shoot and edit some of our most popular articles, including a trip to the Pacific Northwest to work with the legendary Larry Haun. Soon after, Justin became responsible for all our tool and material content, earning him a reputation with manufacturers as the guy who asked the toughest questions at their press events. Justin's own work appeared in many issues of the magazine too, including articles on building decks and sheds, a mantel, a pergola, and a Dutch door, to name a few. Justin was also instrumental in helping to develop *FHB*'s video program, from his short-lived Tool Hound series to his hosting role on the Project House videos to our more recent Shop Class series. Justin is the original host of the *FHB* podcast and he steered the ship as our editorial director for the last two years. Perhaps his most innovative accomplishment was last year's launch of the first Fine Homebuilding Summit, an intense, unforgettable conference that will now become an annual event.

We will miss Justin at the office, but are thrilled to say that this is really more of a shift than a departure. Going forward, Justin will be a full-time builder, but will still be with *Fine Homebuilding* part time as our first builder-at-large. In this new role, Justin will bring us print and video content from his own projects and get back to one of his favorite parts of the job: visiting builders like you to learn and share your expertise with the *FHB* community.

Please join us in congratulating Justin on a job well done and wishing him a bright future with Fink & Son.

—BRIAN PONTOLILO
editorial director

Fall-protection feedback

I really appreciated your article on fall protection. Having worked in remote environments where help can be hours to weeks away depending on the weather, I've become a real safety nut. I keep up on all my OSHA trainings, but I always see a huge gap in what's required by OSHA and what can be practically applied on the job site. Generally, if it's too complicated, guys won't do it. The trainings I receive also tend to apply more readily to massive commercial operations—not the small residential restoration projects I generally work on. So it was really nice to have a very practical guide. I'd love to see this on other topics, such as lead paint remediation and electrical safety for builders.

—LAURA SMARRITO
Philadelphia

Painting sash

Masking Liquid H2O (SPEC, *FHB* #292) sounds like just the thing for us amateur painters, but I would love to hear the opinion of some pro painters on

Photo: Brian McAward

Fine Homebuilding

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your safety

Home building is inherently dangerous. From accidents with power tools to falls from ladders, scaffolds, and roofs, builders risk serious injury and even death. We try to promote safe work habits through our articles. But what is safe for one person under certain circumstances may not be safe for you under different circumstances. So don't try anything you learn about here (or elsewhere) unless you're certain that it is safe for you. Please be careful.

—BRIAN PONTOLILO
editorial director

this point: An old-timer once explained to me (as I was masking my sash) that the best way to deal with this task is to simply get good at it. He explained that a small fillet of paint (1/32 in. to 1/16 in. on the glass) at the glass-wood or glass-putty interface was essential to sealing the joint from water intrusion.

I imagine this is not as critical an issue on interior jobs, but I wonder if this function of paint is being defeated by the use of Masking Liquid H2O on exterior doors and sash.

—MICHAEL LAWLER
Rancho Mirage, Calif.

Incorrect membrane thickness

I think the "Site-built systems" sidebar on page 65 of "Create a Dry Space Under Your Deck" (*FHB* #293) lists an incorrect thickness of rubber or EPDM membranes. A 0.45-in.- to 0.60-in.-thick membrane translates to 7/16-in.- to almost 5/8-in.-thick material. It doesn't exist. I suspect the author mistook mils for inches. Forty-five-mil to 60-mil membranes are typical—a mil is 0.001 in. (about 1/1000 in.). I would hate to be the person trying to spread out sheet material that's around ½ in. thick. It'd be awfully heavy.

—RALPH H. TULIS, P.E.
via email

Another note on fall protection

I agree with Tim Uhler that fall protection starts by doing as much as you can "on the ground." To that end, here's a technique that eliminates much high work:

In some regions, top plates are doubled after walls are raised. The method I learned in New York, however, was to cut and stack all three plate layers (bottom plate, top plate, and doubler) on the deck. The first two layers of this sandwich are tacked in place, and the doubler gets nailed to the top plate everywhere except the laps. Then the top face of the doubler is marked for the next framing stage—beam and joist layout for a second floor, or rafter layout for a roof. Only then are the walls assembled and raised. There is no messing with stepladders to apply doublers after the walls are up, and no "walking the plate" to do layout.

The only potential downside to this method is that studs have to be toe-nailed to the top plate rather than through-nailed. This takes some practice, but once you get proficient at toe-nailing, the method's advantages far outweigh any additional time spent nailing.

—SCOTT MCBRIDE
Sperryville, Va.

Don't overlook the unions

I think it's a serious mistake on the part of the magazine that by far the largest and most effective [craft] "educational opportunity"—the unions' apprenticeship and training programs—aren't mentioned in Keep Craft Alive promotions.

All over the country, there are very thorough and practical four-year apprenticeship programs run by the building trades unions. These unions, their apprenticeship programs, and their journey-level craft, leadership, safety, and certification classes offer all the very programs the Keep Craft Alive campaign aspires to.

I am so grateful to have had an over-40-year career as a union carpenter. I started as an apprentice, but your readers should know you can join with credit for previous experience or at journey level if you are qualified. I enjoyed good wages, health benefits, vacation pay, disability supplements, and use of the hiring hall and free journey-level advancement classes (I learned to weld in my 50s). My wife and I are comfortably retired now with a union (defined benefit) pension, and a union annuity in addition to Social Security.

Like most private-sector jobs, there was no real job security, but I also could leave an employer without losing accumulated benefits. I was able to start my next job at union scale as I often pursued better and more challenging employment.

All these specific enhancements to my life and well-being, and some big general improvements like an eight-hour day, weekends off, public education, and unemployment insurance, are the result of union support. And that's the most important point of unions: They give working people the space for collective action to defend and advance their well-being.

—JUD PEAKE
Oakland, Calif.

Correction

In "A Practical Guide to Fall Protection" by Tim Uhler (*FHB* #293), we incorrectly noted that more than 100 construction workers died on the job in 2018. In fact, over 1000 construction workers died on the job in 2018—a much more sobering figure that emphasizes the need for job-site safety.

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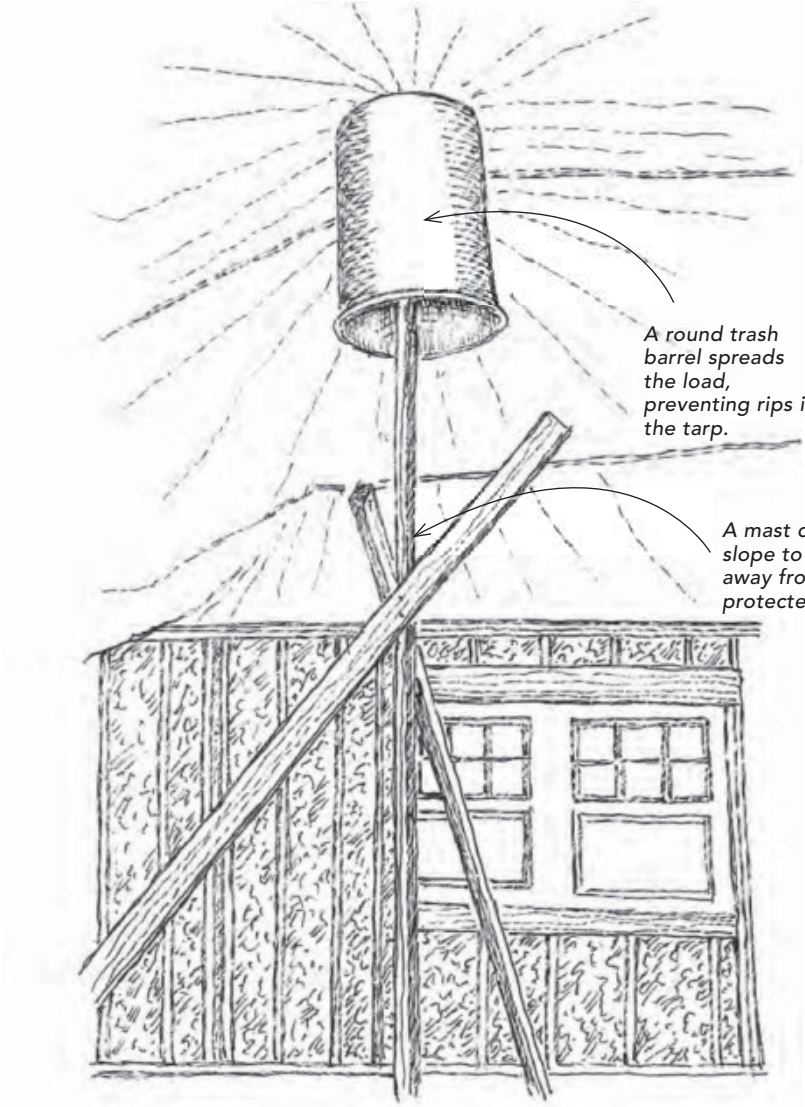


Keep rain off the job

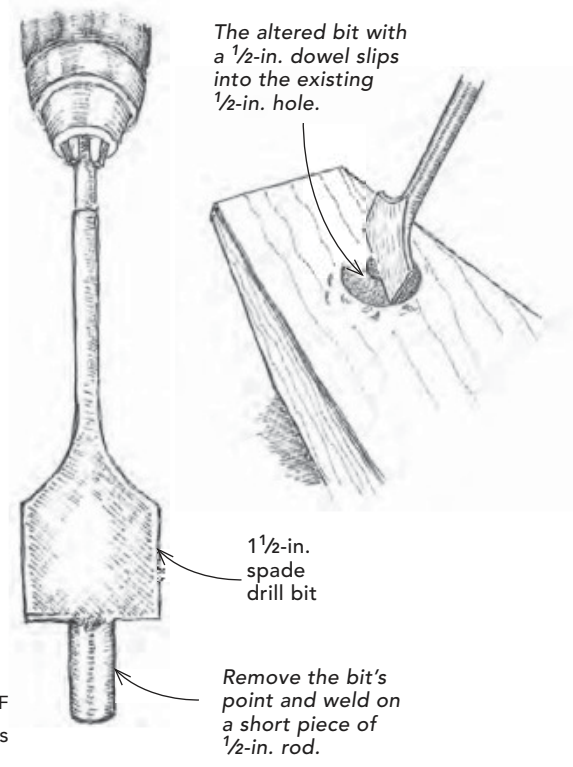
When you need to tarp a job, a mast in the middle helps the temporary roof to drain and prevents ponding. My improvement is a large heavy-duty trash can on top of the mast. The large, flat area of the trash-can bottom, with its rounded edges, keeps the tarp from chafing and tearing. It works like a champ.

—MICHAEL PATTERSON
Gaithersburg, Md.

Countersinking with a spade bit

The most annoying thing about using a spade bit to enlarge an angled hole for countersinking is keeping the bit centered in the existing pilot hole. To make this easy, I cut off the pointed end of a 1½-in. spade bit, and welded on a short piece of ½-in. rod in its place. Now when I put the drill bit into the previously drilled pilot hole, the bit stays centered.

—GERRET WIKOFF
Los Angeles



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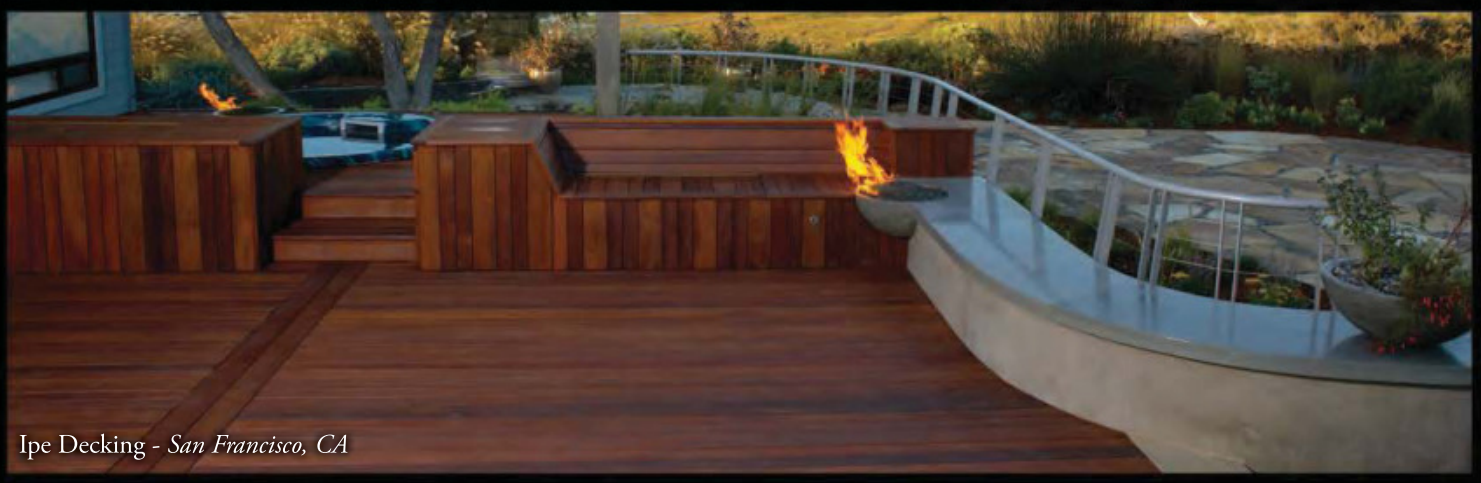

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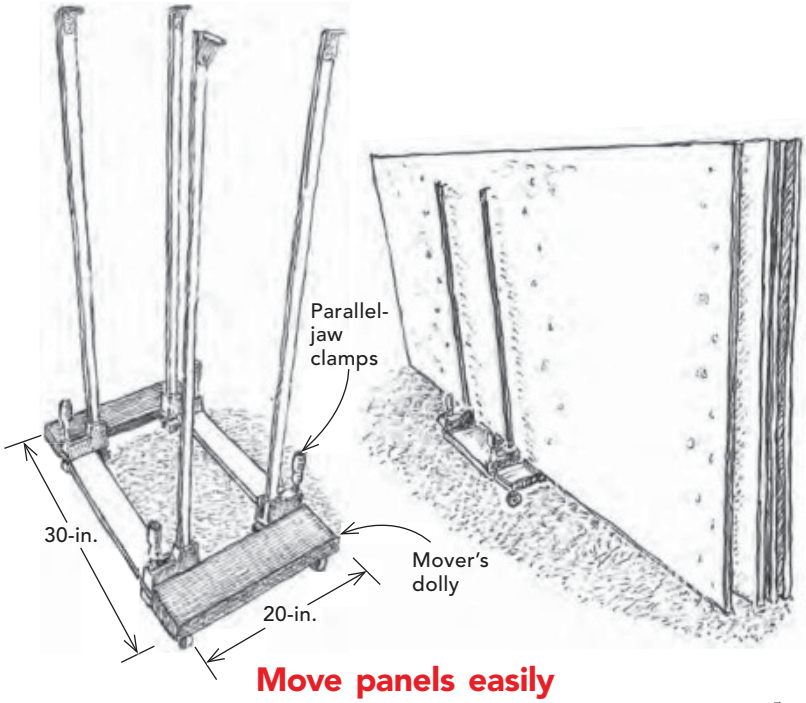
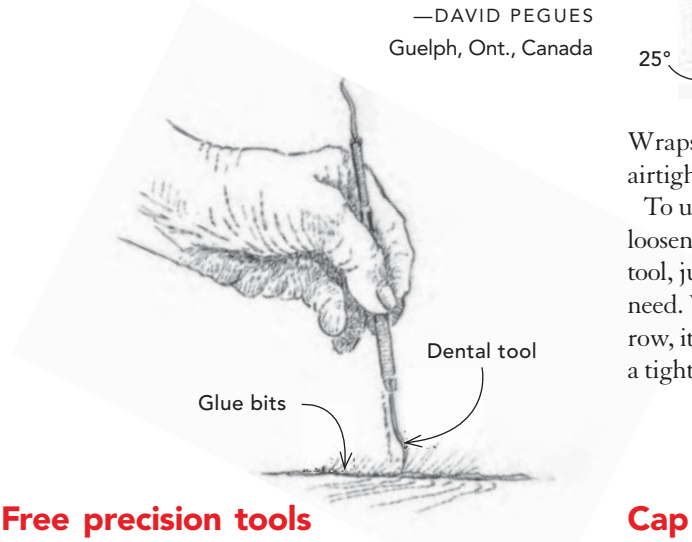


Move panels easily

I am building a house and had to move a stack of ⅝-in. sheets of plywood, but I didn't have a panel cart, telehandler, or any of the other typical back-saving tools for the job. I improvised my own by adding four 36-in. parallel-jaw clamps to a mover's dolly to create a makeshift panel cart, and rolled them 40 ft. into the garage. It was much easier than carrying each one, and the setup works for any sheet material.

—DAVID PEGUES
Guelph, Ont., Canada



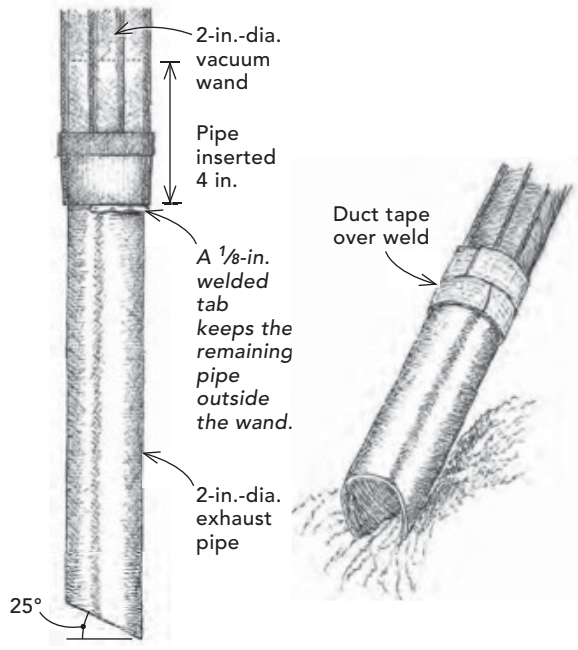
Free precision tools

Every year or so during a dental checkup, I ask my dentist for picks, rasps, and scrapers that are too worn for dental use. For a woodworker, these high-quality surgical-steel tools have plenty of useful life remaining. They're really great for picking dried glue out of corners and replacing O-rings. I've collected enough of these free tools that I have a couple in every toolbox.

—KEITH GOBEN
Seattle

Digging in small spaces

Have you ever tackled the task of digging small holes in tight places, perhaps to run a PEX water line or an underground conduit? I've developed a system that really works. I start with a shop vac with a 2-in.-diameter vacuum wand, and I insert a 2-in.-diameter by 16-in.-long piece of car exhaust pipe into it, leaving 12 in. of the pipe exposed. To keep the pipe from sliding into the wand, I weld a ⅛-in.-thick tab 4 in. from the end, but a short sheet-metal screw would work as well.



Wraps of duct tape over the weld make the connection airtight. Cutting a 25° bevel on the tip completes the rig.

To use, push the tube forward and scrape at the soil to loosen it, and the vacuum sucks it up. To lengthen the tool, just add as many sections of plastic wand as you need. With two shop vacs, a laborer, and a wheelbarrow, it is amazing how much dirt you can remove from a tight space in a short time.

—DAVID CROSBY
Santa Fe, N.M.

Cap caulk tubes

For years I've tried various methods and products for capping off tubes of caulk, roofing cement, and adhesive. Finally, I've landed on a way that's quick, easy, and cheap: Just snip off a finger of a disposable glove, put it over the end of the tube, and shoot about an inch of the goop into the glove finger. Shape the goop around the tip of the tube to seal it off, and you're done.

—SUSAN O'NEIL
Homosassa, Fla.

know the code
MASTER THE RULES OF HOME BUILDING

BY GLENN MATHEWSON

Maximize insulation in minimum headers

Conventional wood-frame construction is incredibly entrenched in the idea of, "We've always done it this way." Unlike a lot of newer parts of codes that are based on laboratory testing or engineered design, conventional wood-frame construction is proven empirically. Buildings framed on 16-in. centers with the same big header over every opening have a long track record of remaining upright—all the evidence you need to know it works.

Meanwhile, engineers have done the math and shown that we can use less framing and wind up with a building that stands up just as well as the old ones. These "advanced framing" techniques, such as widening the spacing between studs and right-sizing headers for the loads they have to carry, have been around for decades, but haven't really caught on in the broader residential construction market. Some builders and designers are reluctant to change when what they've been doing works. Others just refuse to believe this newfangled framing could be as good as the old stuff.

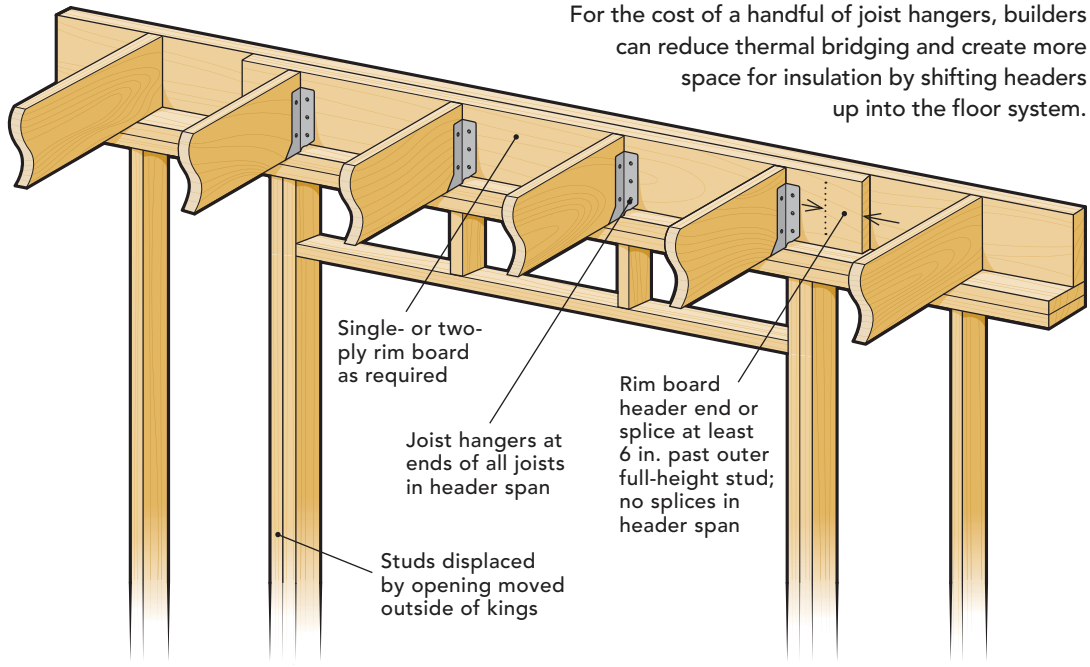
Regardless of opinion, building codes have incorporated these engineered-framing concepts. They aren't mandated, but they are permitted. Builders who don't care as much about thermal bridging or excessive lumber in their walls can keep doing things the old way. Those with an eye on energy savings and conserving resources can do it the new way. Both ways are "code minimum," but the outcomes in terms of a home's energy performance are drastically different.

Probably the easiest and most widely adopted change from conventional framing is how we build headers. These are the beams that span over wall openings—typically windows and doors—and transfer the loads imposed on them down the sides of the openings through jack studs, and eventually down to the foundation. When I was framing homes in the late '90s, we simply built headers to fit the width of the wall. Two 2x10 plies and a 7⁄16-in. OSB filler did the job for pretty much every opening in 2x4 walls. This configuration was often specified on the plans by designers as "(2) 2x10 typ." The "typ" stands for "typical," and essentially translates to "this is good enough and I don't feel like evaluating each header individually."

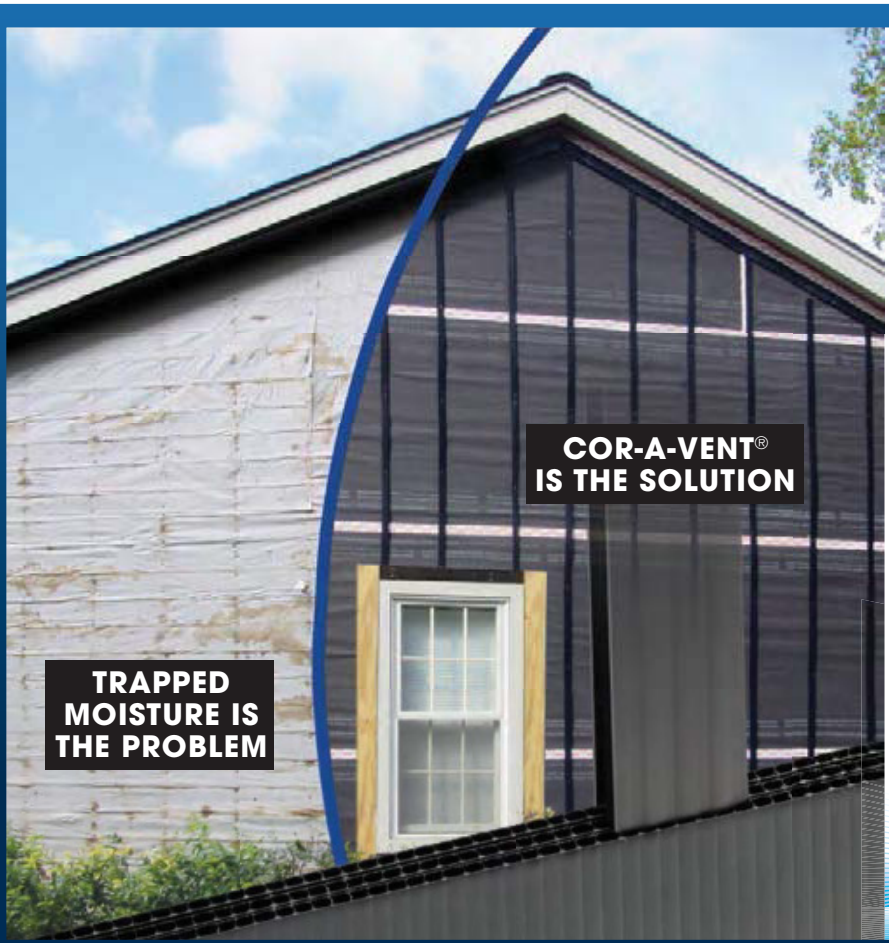
When minimum R-values began to increase in the 2009 I-codes, which serve as the model for building codes

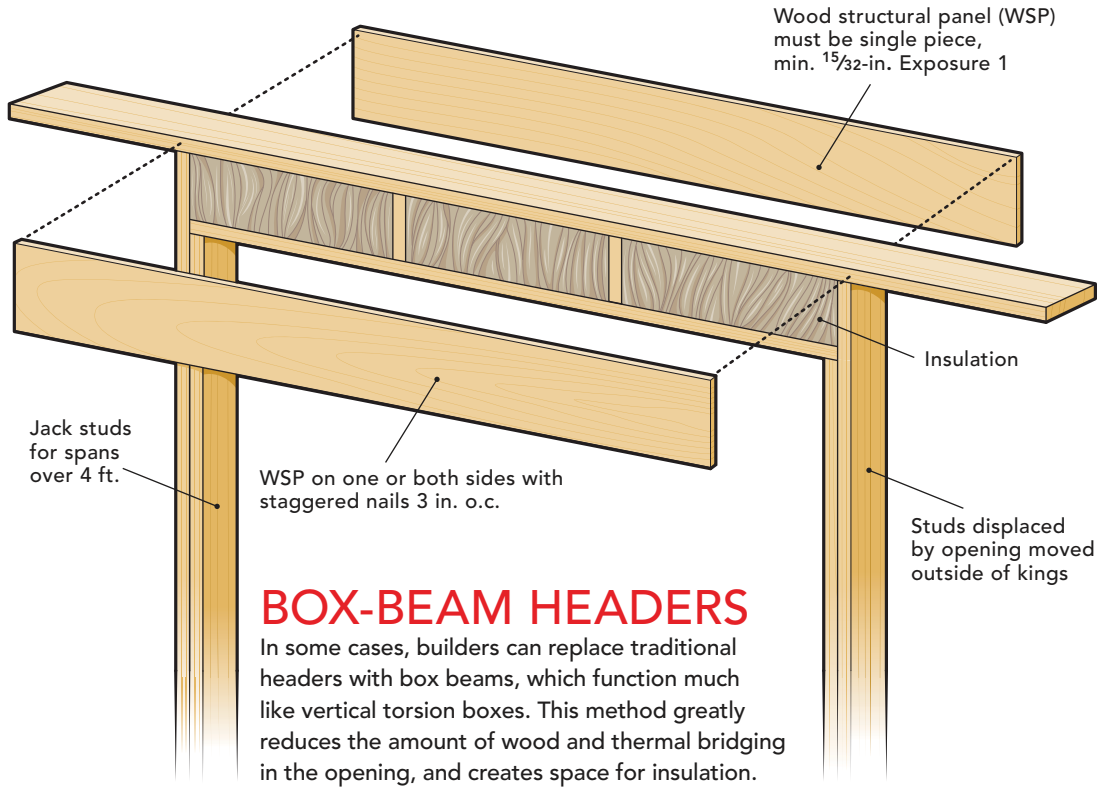
RIM-BOARD HEADERS

For the cost of a handful of joist hangers, builders can reduce thermal bridging and create more space for insulation by shifting headers up into the floor system.



Drawing: Kate Francis





BOX-BEAM HEADERS

In some cases, builders can replace traditional headers with box beams, which function much like vertical torsion boxes. This method greatly reduces the amount of wood and thermal bridging in the opening, and creates space for insulation.

across the U.S., many regions had to increase from 2x4 wall construction to 2x6, simply to provide a bigger cavity for insulation and not for any structural reasons. The industry response was simply to change the "(2)" to a "(3)"—the "typ" now a three-ply header sufficient to fit the wall thickness. The larger header has no structural motivation; it was just the easy thing to do. That a combination of 2x headers and ½-in. spacers fills a 3½-in. and 5½-in. wall perfectly seems conveniently meant to be. As attention to energy codes began to increase, however, we saw the industry make voluntary changes to this practice.

It's no longer the norm to fill out that header just to fill the depth of the wall. If three plies aren't structurally necessary, then two 2x plies are used in the 2x6 wall. The OSB filler is gone, and the header plies are fastened together and favored to the outside face of the wall studs. We finally separated header size from wall thickness.

Starting in 2012, the International Residential Code (IRC) began requiring any cavities in headers be insulated. It's important to note this is not to say that headers are required to be insulated or that minimum-size headers must be used. It only says that if you have cavities in your header, they must be insulated to at least R-3 per inch.

Though this appears to be where the industry has settled, the IRC offers so much more choice in design and better-performing options. As you read the rest of this column, it's critical to realize that two homes "built to minimum code" can have tremendously different thermal performance. Where often "the code" is looked at as restrictive, this is a subject in which the code offers much more choice than is generally utilized. There is still a lot more we can do with headers to increase energy performance. Perhaps it's time to consider some new conventions in conventional header construction.

Size matters

There's little value in overbuilding the structure of a home, unless lifestyle of the occupants is being addressed—a large soaking tub or heavy gym equipment might be reasons to thoughtfully overbuild. Most overbuilds are the opposite—they're overbuilt because they weren't thought out. The overbuilt "typ" header is for convenience, not performance. Putting one in a non-load-bearing wall, for example, robs the house of insulation potential, since wood doesn't have near the R-value of insulation of the same volume.

While a bigger-than-necessary header could be useful if snow loads suddenly increased in the future (unlikely), fighting the daily movement of heat in and out of your climate-controlled home is always valuable. While energy prices are likely to continue to increase, the resistance to energy movement through the thermal envelope stays constant. That means the insulation installed today only becomes more valuable, saving you more money as energy prices go up. Unlike splurging on a kitchen range or granite countertops, there's really only one good time to invest in insulation—when the house is built. And in some cases, insulation is actually cheaper than the wood it's replacing.

Move it up

There's a really simple way to allow for a smaller header while hardly changing anything about "how we've always done it." Rather than set the header flush with the top of the opening, move it up tight to the top plate. In this location, with the header additionally fastened through the top plate, the floor or roof rafters are able to provide lateral resistance to the header, increasing the load it can handle. In fact, if you look at the header tables in the code, all of the listed spans are contingent on headers having this lateral support. If the header is lower down with cripples above it, the span rating has to be reduced by multiplying the given span by 0.7. In other words, if the table says a given header can span 4 ft., but the header has cripples above it, its actual span is reduced to 2 ft. 9⅝ in. (4 ft. x 0.7). Unless you move the header up, you have to upsize it and take the penalty of reduced insulation volume and increased thermal bridging. This is a new revelation for the IRC, which explains this span reduction in a new footnote under the tables for exterior

Drawing: Kate Francis

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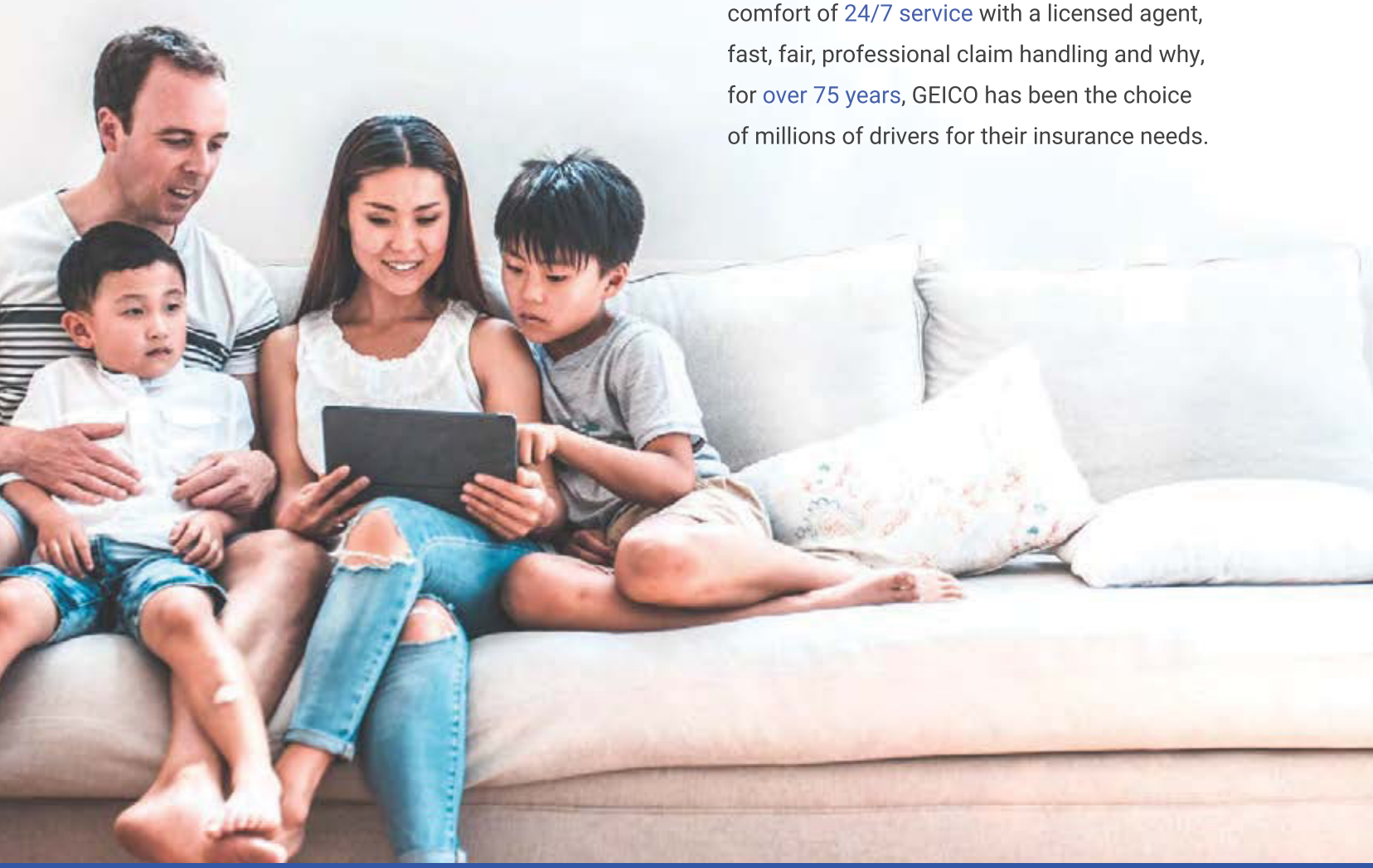

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wall girder and header spans in the 2018 edition.

Use single-ply sparingly

Unfortunately, humans are easily captivated by catchy headlines and good marketing. Similarly, the I-codes have some provisions that look great at a glance, but aren't that big a deal when you get into the details. That's generally the case with single-ply headers in load-bearing walls, which were first included in a unique table in the 2012 IRC. In 2018, the IRC added new rows to this table, Table R602.7(1), but that's just the headline. There is more to a header than just its ability to span an opening. It also has to transfer whatever loads it carries to the jack studs below.

The IRC makes load assumptions based on the size of the opening. The wider the opening, the higher the load that gets transferred through the header and to the jack studs. Connected to the king studs, the jacks create a post to transfer the concentrated load from the header to the foundation. When looking at Table R602.7(1) for the relationship of header span to size, there is also a column for the number of jack studs required at each end of the header. As the span gets longer, the number of required jack studs generally increases.

Allowable spans for single-ply headers are very short, but in almost all cases at least two jack studs—and sometimes as many as four—are required on each end. Move down the table column to two-ply headers with similar spans and you only need a single jack stud. For example, a single 2x6 has the same max span as two 2x4s, but it requires twice the number of jack studs. This is not a typo, but it's counter to the logic of including single-ply headers in the tables—namely to increase insulation volume.

> "If you read past the headlines, you may find single-ply headers are in many cases just 'fake news.'"

Adding two or more jack studs to remove one short ply of header results in an overall increase in wood volume and a decrease in energy performance. And it's not just about insulation. Studs create additional thermal bridges straight through the wall. A two-ply header was already short of connecting the inside face of the wall to the outside face, so removing a ply itself has little effect on thermal bridging, while adding additional jacks ramps it up. If you read past the headlines, you may find single-ply headers are in many cases just "fake news."

The no-ply header

How about we just remove all the large header plies and, in some cases, all the jack studs? You can do that in a nonbearing wall, and probably should, but I'm still talking about bearing walls. A box-beam header removes all standard header plies and allows the wood structural-panel sheathing to do the work.

Section R602.7.3 and its accompanying table and illustration lay out all the details for box-beam headers, which can be either 9 in. or 15 in. tall. The basic structure includes a 2x on the flat, cripples at regular stud spacing, and a wood structural panel on one or both sides, with its strength axis parallel to the top plate and fastened with nails 3 in. on center. This configuration replaces a lot of wood volume with insulation. If you already wrap your exterior walls in wood structural-panel sheathing, the only added work for a one-sided box-beam header is driving a handful more nails.

Put it in the floor

Though headers have typically always been in walls, the span table for headers lived much of its life in the floor chapter. That could be because the loads on the header come from the floor or roof above, or maybe it was just misplaced, but it wasn't until the 2015 edition that the header table moved to the wall chapter. Ironically, in this same edition, a brand new section and figure—R602.7.2, Rim Board Headers—was added to provide prescriptive design for moving the header completely into the floor framing. Now we might be on to something.

When a header is moved into the rim-joist area, the single rim-joist ply becomes one of the header plies—and for small openings, additional plies might not be necessary. Sizing of rim-board headers uses the same table as standard headers. There are some details not to miss in this design, such as using joist hangers to support joists over the opening. The rim-joist header must also extend at least 6 in. beyond the end supports. Instead of jack studs, the full-height studs displaced by the opening are ganged up on either side of it to carry the load on the header. Overall, this method can significantly reduce the amount of lumber needed to frame an opening—especially large ones.

But just as significant is the space it makes available for insulation. While the wall thickness is a limiting factor in how much insulation can be jammed into a standard header, the cavity inboard of the rim joist can span the width of the building. The horizontal thickness, and thus total R-value, can be much more in a floor than in the wall. The number of plies in a rim-board header is no longer as significant of an issue. For high-efficiency, prescriptively designed homes, this may be the best choice.

One takeaway from all of this is that none of these better-energy-performing framing methods is required. If you want to keep building to the minimum the old-fashioned way, you are welcome to. However, you can also build to the minimum in a more thoughtful way—a way that doesn't feel "minimum" at all. Through education, "the code" can be more than just the restrictive, freedom-limiting burden many designers and contractors view it as. It can also be a tool box.

Glenn Mathewson is a consultant and educator with buildingcodecollege.com.

HIGH-QUALITY, REASONABLY PRICED TESTERS

If you're going to work on wiring, you need to be able to locate the right circuit breaker, cut the power, and then verify that the power is off. When you're done, you need to make sure your work is correct. Klein's new line of affordable, high-quality testers can do all these things. Always check operation on a live circuit and make sure the tester's body and leads or cord are in good shape before using them.

Cliff Popejoy, an electrical contractor in Sacramento, Calif.

Klein ET40 Voltage Tester
$15

This voltage tester uses insulated probes (with steel tips) on short leads to measure both AC voltage (12v to 240v) and DC voltage (1.5v to 24v). It has a ladder-type display, with LEDs that light based on the voltage. The LEDs are bright enough to see in direct sun. It's great for testing AC voltage at both 120v and 240v switches, devices, and receptacles. It's also good for checking voltage from landscape lighting or transformers. It uses two AAA batteries and shuts off after a couple of minutes to save battery life. It also has a low-battery indicator.

Klein RT310 Outlet Tester
$40

This polarity tester checks regular 120v receptacles for open ground, open neutral, open hot, hot/ground reverse, and hot/neutral reverse. It also tests AFCI and GFCI functions. It's powered by three AAA batteries, includes an auto shutoff, and has a 9-in. cord with a plug so you can test outlets that aren't easily accessible. Notably, it can tell if the outlet has power, even if both the neutral and the ground wiring are interrupted. No other outlet tester has this capability.

Klein ET310 Breaker Finder
$40

The breaker finder helps you determine the circuit supplying an outlet. The transmitter unit plugs into the socket and sends a tracing signal down the wires, and the receiver allows you to identify which breaker feeds that wire. The transmitter runs on 120v and also checks the polarity of the outlet. The receiver uses a 9v battery, has an auto-shutoff feature, and is more accurate than any finder I've used in this price range. It won't trace a dead circuit, and sometimes it takes experience to narrow down which of two breakers is the right one, but for the price it can't be beat.

Photos: this page, Cliff Popejoy; facing page, courtesy of TSO Products

Clever crosscut adapter

Track saws are back- and labor-savers, but getting a perfectly square cut requires extra time-wasting measurements or using another tool to square the track to an edge. The GRS-16 Guide Rail Square from TSO Products ($160) clips onto your track-saw track and locks on with a draw catch, creating a 90° fence for faster and more accurate crosscuts and rips. The tool is made from anodized aluminum and can be positioned anywhere on the track.

I primarily use the GRS-16 when breaking down sheet goods, but it's also good for trimming doors. I use mine in the shop and store it on my cutting table (see "Make a Sturdy Shop Table," *FHB* #292), but it's also easy to keep in a truck because it's small and lightweight.

I bought one as soon as it came on the market and I couldn't be happier. It fits on both my Festool and Makita track-saw tracks, and the manufacturer says it fits Triton's tracks too. The company also makes other useful track-saw accessories, including adjustable stops for repeat cuts and track connectors that don't require a straightedge.

Peter Polcyn, a furniture and cabinet maker and the owner of Rail and Stile Custom Woodworks in Seguin, Texas.

Help with heavy doors

After 20-plus years of hanging doors, I've worked out a system: A couple levels, a bucket of cedar shims, and some fasteners are all I need. It's usually an easy process, except for one step: handling the slabs. Until recently, I would have carried the slabs by hand, gotten the hinge barrels close, and then put the slab in place, hopefully without pinching my fingers. But now I use The Door Stud Pro Series, a set of "U"-shaped metal skates with locking casters. They hold the door with toggle clamps and the casters adjust the door from ⅛ in. to 2¼ in. off the floor.

I place the jigs onto the door bottom while it's on its side, then stand the door upright to roll it around. When the door is in the opening, use the height knobs to raise the slab and align the hinges. Once the door is hung, undo the clamps and lower the skates a bit to slide them out.

The Door Stud Pro really proved its worth hanging five pocket doors. Pocket doors are frustrating to hang because you have to line up the hardware while balancing the door. But with the Door Stud, you can align the rollers and then raise the slab to them. The aggravation saved on this one job was worth the cost alone.

Ben Bogie, production manager for Kolbert Building in Portland, Maine.

Door Stud Pro Series
Weight capacity: 250 lb.
Price: $250

Photo: courtesy of the manufacturer


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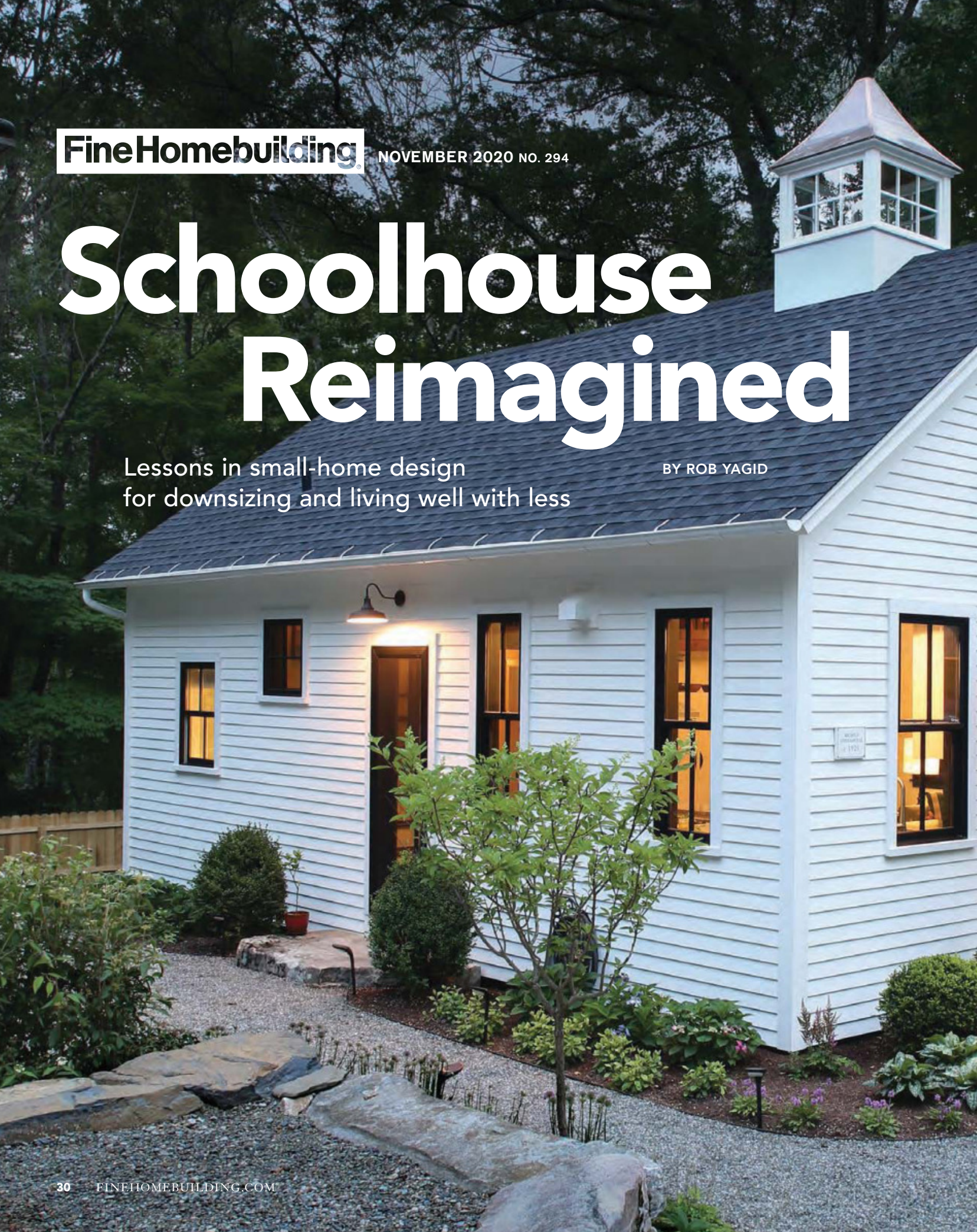
Schoolhouse Reimagined

Lessons in small-home design for downsizing and living well with less

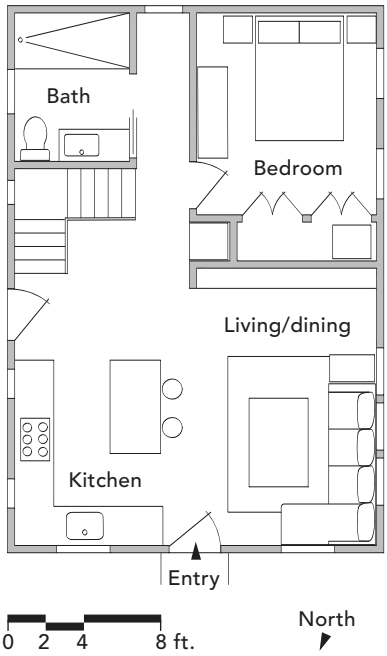
BY ROB YAGID



Floor-plan drawing: Patrick Welsh

The Bromica School House sits at the corner of intersecting dirt roads in Kent, a small town along the Housatonic River in northwestern Connecticut. Constructed in 1920, it was among 14 one-room schoolhouses in service to the region. By 1950, the school, along with only a handful of others left in the area's more remote hills, had closed its doors for good. It since served as a single-family home, but fell into severe disrepair by the late 1990s. By the time a local carpenter and his wife—my parents—purchased the property in 2019, there had been multiple attempts to restore it. The latest, initiated by a local architect who had the building gutted, left them with a blank slate to create a comfortable, functional, and fun home where they could enjoy retirement.

The rebuilding of this home was an exercise in imaginative small-home design, where core living spaces are creatively arranged to make the most of the home's footprint on the nonconforming lot. The upgrades in both performance and aesthetics were based on comfort and a real-world bud-



DEFINED SPACES

The floor plan organizes public, private, and flexible spaces amidst the open plan to bring order and functionaily to the design. A large patio steps away from the kitchen provides an open area for entertaining friends and family.

SPECS

Bedrooms: 1

Bathrooms: 1

Size: 850 sq. ft.

Location: Kent, Conn.

Designer/builder: Paul and Angela Yagid

Landscape: Richard Schipul, designingeden.com

SEPARATE, TOGETHER

Many homeowners associate comfort with volume. The larger the space, they think, the better it must feel. Often, the most uncomfortable spaces are those that tend to meander on, where there is no order or definitive area to occupy. Even in a small home, you can create a definitive delineation of "rooms" through choices in finish materials, furnishing, and even lighting.

A VIEW WITH NO END IN SIGHT The living room is defined by a wall of built-in cabinetry adjacent to the kitchen, and the natural timbered ceiling in the main hall guides you to the private areas of the home. A window strategically placed at the end of the hall allows your view from the front door to be carried straight through the house and into the trees.

get, with the intention of giving the home a more modern look and feel without erasing all semblance of its rich history—a practical approach that can be replicated in any project, whether new or extensively remodeled.

A few years ago, my parents found themselves living in a home they loved but that no longer fit their lifestyle. At 3400 sq. ft., the traditional colonial that my father built many years prior had become much too large for their needs and for how they wanted to spend their time. When most people consider downsizing, they don't quite envision living in a home that's a quarter of the size of their former residence. But the schoolhouse was too charming to pass up. And while small-home living has its challenges, they were more than willing to take them on. A truly small home demands letting go of a lot of material items, keeping what matters most, and adjusting your living patterns. When designed well, however, a small home affords a certain level of comfort that can't as easily be found in larger houses.

Because the house is on a nonconforming lot, no additions would be approved by zoning. There would be no easy outs in develop-

A CORNER KITCHEN Granite-topped counters set flush with the windowsills reduce the visual barriers between the kitchen and the outside patio. Hidden in the beams above, spotlights illuminate the island and in the evening help set the kitchen apart from the other spaces.

WINDOWS MAKE THE SPACE The three tall windows in the main living room flood the space with light and offer abundant views. Their tall head height, combined with the vaulted ceiling, helps enhance the perception of space. The coffee table transforms the room into a dining area that can seat up to ten (see p. 37).

AN AWAY SPACE Every home, no matter its size, needs a space for personal retreat. The loft is that space in this home, and it serves as a home office, a reading lounge, and even sleeping quarters for visiting grandchildren and guests. As much space as possible beneath the eaves has been captured for seasonal storage.

ing the floor plan. Fortunately, the existing structure had a few key elements that were retained and enhanced to make it all work. The first was the vaulted ceiling. The second was a small existing loft at the back of the structure, and the third was a trio of tall beautiful windows that undoubtedly once drew the attention of daydreaming students who could gaze up at the tops of the nearby maple trees. It only made sense to anchor the main living area adjacent to these windows—updated with double-hung Marvin Integrity units in the same proportion as the originals—in order to take full advantage of the light and views they provide. With the living room and kitchen placement positioned at the front of the house, the bedroom and bathroom were located in the opposing rear corners, compressed beneath a rebuilt loft that now serves as a flex space.

The idea of "compression and release" in the context of spatial planning is a hallmark of Frank Lloyd Wright's approach to design. Even in a home as small as this, you can still achieve some of the experience this strategy yields by being mindful of the scale of rooms. Private spaces like the bathroom

LET THE DETAILS SHINE

In a small house, a few quality items can really stand out and establish the style of the home. Here, particular attention was given to the things used and experienced most often, which were budgeted for accordingly. It's a good lesson: The things you use and touch on a daily basis should be of the best quality you can afford.

MARBLE, GLASS, AND WOOD The subway-tiled shower, glass rolling door, and marble-topped vanity provide a clean, contemporary look. The ceiling is clad with original random-width boards above existing beams, adding richness and warmth.

A SIMPLE, SUBTLE SOLUTION The nickel-gap cladding, placement of windows, and lack of upper cabinets at the range wall made conventional tile-backsplash options problematic. The solution was to choose a backsplash that virtually disappeared. It is made of glass that was custom-cut locally and back-painted by ColorKote of Stratford, Conn., to match the Benjamin Moore white on the walls.

and bedroom don't need to be large, and certainly don't need vaulted ceilings. Rebuilding the loft to lower the ceiling height in these spaces, and the small hallway bridging the two, helped create a dynamic floor plan. It has the feel of an open plan, but with the functionality of a well-organized and compartmentalized design.

With the core spaces defined within the existing footprint, light and views became the focus when discussing how to make the small spaces as inviting and attractive as possible. In a small home, subtle moves have major impact. For instance, a window with a tall head height will always make a room feel larger than it is. Glazed exterior doors or a window placed at the end of a hallway allows your view to extend beyond the walls to the outdoors and makes a space feel expansive. Even a small window in a stairwell landing can create a major impression. Its scale and placement is fun in that it's somewhat unex-

MORE THAN JUST A SET OF STAIRS The stairs to the loft serve as a focal point as much as functional access. A small window and sconce in the landing illuminate the stairwell and a built-in bookcase gives additional utility. The railing by View Rail adds a slightly modern touch. The handrail is made of salvaged chestnut from parts of the original interior framing. Every time you ascend to the loft, you're grasping at history.

SMALL-HOME SOLUTIONS

There are a few key elements in this home that increase the flexibility of spaces and offer problem-solving solutions for designing and constructing tight, sometimes constricting, areas. These are products you might consider for your next small-home project.

A TIGHT-FITTING FRIDGE Due to their size, refrigerators are notoriously problematic when designing small kitchens. Fortunately, Liebherr has several options to consider. This unit is only 30 in. wide, 24 in. deep, and 80 in. high and has a robust amount of storage.

STACK EFFECT The Miele Stackable Compact washer and dryer easily tucks into the master-bedroom closet. The dryer is a condensing unit, so traditional venting isn't necessary, which makes placement within a small home much easier.

pected, and the light it provides brings life to an otherwise dark corner. In combination, all these design moves have helped create a home that belies its diminutive size.

It's borderline inaccurate to refer to this project as a remodel. The only original elements are the stone foundation, the frame-and-board sheathing, and the fir flooring. Everything else was replaced or added, including a new well and septic. But whenever walls and ceilings are exposed—or siding is removed—there's an opportunity to improve the efficiency of a home. In this instance, there was the potential to reduce the operating cost of the house, make it far more comfortable than at any other time in its hundred-year history, and reduce its resource consumption without an over-the-top insulation and mechanical package.

The true 2x4 walls were sprayed with open-cell spray foam and enough rigid foam was added to the exterior to move the dew point outside the wall cavity. While the board sheathing has a much better buffer capacity than modern sheathing when wetting and drying, the walls were still designed to be able to dry to the interior. The ceiling was addressed exclusively from the interior in order to avoid changing the home's aesthetics and to make the most of a finite budget. Polyiso rigid foam was cut to fit between framing members and air-sealed in place to create a hot roof that would yield as much insulating value as possible. Below, the crawlspace was detailed with heavy-duty poly sheeting to reduce moisture migration into the basement and insulated with a combination of closed-cell spray foam and high-density fiberglass batts. A new forced-air system,

A COFFEE TABLE THAT SEATS TEN The coffee table in the living room is built by Expand Furniture in Vancouver. It lifts and separates to become a table when entertaining guests. Extension leaves are stowed inside when not in use. Here, it's set for eight with Nano padded folding chairs, also by Expand Furniture, that take up a mere 13 in. of depth when stacked together.

an on-demand water heater, and an HRV keep the house comfortable and supplied with fresh air. While the home has not been tested or certified by any third-party energy programs, it has been retrofitted to perform well above what the local code demands, providing resiliency and economy.

When people see this home, or experience others like it, they tend to make associations with moments or experiences in either their own lives or in our collective history. They think of a simple life or of a simpler time. They're appropriate thoughts, because a small home forces you to streamline the things in your life. By distilling its design, a small home—and the lifestyle it reinforces—gives you the room for experiences that are more spiritual in nature than they are tangible, and that ultimately tends to feel more fulfilling. Within the frenetic world we live, it's alluring.

William Henry Channing, a philosopher and friend to Henry David Thoreau—whose cabin at Walden is among the most influential small homes in our history—has a quote that describes the ethos of the transcendentalists of the time: "To live content with small means; to seek elegance rather than luxury, and refinement rather than fashion." While my parents are not transcendentalists, this very sentiment is realized in the completion of their new home. It's all that they need at this point in their lives, and it's all that they could want. □

Rob Yagid is former editorial director of *Fine Homebuilding* and Green Building Advisor, and founding director of Keep Craft Alive. Photos by the author.

Tool Test

Folding Sawhorses

We put a stable of sawhorses through their paces

BY PATRICK McCOMBE

Like every carpenter who's been at it long enough, I own or have tried several sets of commercially made sawhorses. I've also used homemade wooden horses quite a bit. The problem with site-built horses is that they're heavy and big. I just don't have the room in my truck or shop for a set of nonfolding horses, so when former editorial director Justin Fink asked me about my interest in testing commercially made sawhorses, I was intrigued.

When I started digging into what's available, I found a surprising number of different designs, weight ratings, and degrees of compactness. The lockdown in response to the outbreak of COVID-19 brought a unique challenge to my test—since I couldn't go out shopping, I ordered the best-selling folding sawhorses on the Lowes, Home Depot, and Amazon websites. I ended up with 13 sawhorses, in two types of setups—fold-flat and fold-up. Both have their pros and cons, and which to use depends on what you're doing and your budget. In more than 20 years of testing tools, I can't think of a tool category with a greater diversity of products with such different features and attributes.

I was a little hesitant about this particular tool test because sawhorses are such a personal choice. Different users value different attributes. I routinely use sawhorses for rips on panel products, so I need the ability to add sacrificial lumber to the top of the horse. I also prefer adjustable-leg models because they can be made taller than fixed-leg versions (which are usually around 32 in. tall). I tested each of the various setups the same way: I loaded them with PT lumber, set them up on soggy, uneven ground, and cut both sawn lumber and panel products. Prices and weight ratings are based on a pair of sawhorses, and all measurements are my own. □

Patrick McCombe is senior editor. Photos by the author, except where noted.

Photo this page: Rodney Diaz

FOLD-FLAT SAWHORSES

Fold-flat sawhorses are light, reasonably compact, and great for light-duty tasks like painting or trimming a door. They fold up easily and slim down to about 2 in., so you can tuck them into small spaces. The DeWalt and Ridgid models have adjustable steel legs, greatly increasing their utility and load rating. All the flat-fold horses I tested have plastic feet, so they won't mar wood or laminate floors or leave rust stains on concrete. Only Ridgid's Lumberjack has provisions for a sacrificial top.

RIDGID LUMBERJACK

PRICE $100 **WEIGHT RATING** 3000 lb.

HEIGHT 31 in. to 39 in. **LENGTH** 28 in.

WEIGHT PER HORSE 16 lb.

This is the best fold-flat sawhorse I tested. My favorite feature is the replaceable 2x4 top rail that makes it easy to rip panel products and fasten jigs. I also like that you can clamp along its entire length and you can make the top larger by screwing another board on top. This horse also has the best shelf. It's sturdy, and small parts don't fall through. Another great feature is the leg adjustment—you don't have to pull a release to raise the legs; just step on the feet and pull the horse up and they extend. Lowering the horse is simple: The orange handles under the tray act as a release on each side. Combine these features and the weight capacity, and the Ridgid is an easy choice for Best Overall.

FOLD-UP SAWHORSES

With one exception, fold-up sawhorses have legs that fold into or under the body of the horse. When folded, it makes for a very portable package. Unlike the fold-flat variety, which are mostly plastic, these horses are made of steel, so generally they're bigger, heavier, and have higher weight ratings than the fold-flat variety. Some have telescopic legs, and most can be used with clamps if you add a 2x6 or wider piece of sacrificial stock. The Trojan horses don't fit in their own housings—they don't have them—but they're practical, tough, and equally compact.

TROJAN TS-35

PRICE $165 **WEIGHT RATING** 4000 lb.

HEIGHT 35 in. **LENGTH** determined by 2x top

FOLDED DIMENSIONS 5 in. by 5 in. by 36 in.

WEIGHT PER HORSE 16 lb.

I've seen these horses on job sites for 25 years. Everyone I've met who's owned a set talks about their common-sense design, unsurpassed capacity, and durability measured in decades. They're also extremely portable when folded and their length is only limited by the length of 2x stock for the top. They're likely overkill for a hobbyist, but they're perfect for pros who want tough everyday horses that work without drama. Just make sure to work the spreaders with your foot or risk losing a finger. Even with the caveats, this is the sawhorse you won't break or outgrow.

FOLD-FLAT SAWHORSES CONTINUED

DEWALT DWST11031

PRICE $80 **WEIGHT RATING** 2500 lb.
HEIGHT 32 in. to 40 in. **LENGTH** 27 in.
WEIGHT PER HORSE 14 lb.

This was my second favorite fold-flat sawhorse. It has adjustable steel legs and a sturdy shelf with only a pair of holes, so stuff is less likely to fall through. Like nearly all the other fold-flat sawhorses, you can't mount a sacrificial board to its top. And unfortunately, you have to squeeze the release and adjust each leg individually. I've had a set of these for several years. They work fine and have held up well.

KOBALT 514691

PRICE $40 **WEIGHT RATING** 1000 lb.
HEIGHT 31 in. **LENGTH** 27 in.
WEIGHT PER HORSE 6 lb.

The Kobalt and Stanley fold-flat sawhorses are nearly identical. The slope-sided design limits where you can use quick-adjusting bar clamps to the part of the top that overhangs the legs. Without adjustable legs, they are also too short for me to work at a comfortable height. Unfortunately, the two halves on one of the Kobalt horses were misaligned, so I couldn't get a 2x in the slots that are supposed to be made for them.

FOLD-UP SAWHORSES CONTINUED

BORA PORTAMATE SPEEDHORSE

PRICE $160
WEIGHT RATING 3000 lb.
HEIGHT 31 in. **LENGTH** 45 in.
FOLDED DIMENSIONS: 3x6x45 in.
WEIGHT PER HORSE 19 lb.

The Speedhorse has "quick-deploy" technology—you pull a side-mounted catch with a couple fingers and the legs drop out of the body, which is pretty cool. The top is predrilled for a sacrificial board, and it has notches on both ends to receive 2x stock. The legs conveniently fold into the body in any order, but they're not height adjustable.

DEWALT DWST11155

PRICE $80
WEIGHT RATING 2000 lb.
HEIGHT 32 in. **LENGTH** 44 in.
FOLDED DIMENSIONS: 5x5x44 in.
WEIGHT PER HORSE 12 lb.

This is the sawhorse reinvented. Light and strong, the top is made from rectangular tubing. The design allows you to clamp almost anywhere along its length and a "V" on both ends allow you to hold pipe, tubing, and round stock. There are even latches on the ends for connecting the horses when folded, so you can carry a pair one-handed.

EBCO SS-29

PRICE $40
WEIGHT RATING 2000 lb.
HEIGHT 29 in. **LENGTH** 31 in.
FOLDED DIMENSIONS: 7x6x31 in.
WEIGHT PER HORSE 10 lb.

Made from galvanized sheet steel, the Ebco has edges sharp enough to warrant a warning sticker in two locations on every horse. It's a design I first used over 25 years ago and am happy to have abandoned. On the plus side, the top is predrilled for a sacrificial top, but the legs aren't height adjustable and the whole package is rickety.

FORUP

PRICE $50
WEIGHT RATING 530 lb.
HEIGHT 31 in. **LENGTH** 39 in.
FOLDED DIMENSIONS: 3x4x39 in.
WEIGHT PER HORSE 9 lb.

I was intrigued by these horses because of their super-small size when folded and their low price. Stay away—that's all they've got. If you try to slide them when they're open, the spreaders holding the legs are jostled out of place and the legs fold up as you're dragging. To add to the disappointment, some of the bolts were left loose at the factory.

STANLEY 060864R

PRICE $40 **WEIGHT RATING** 1000 lb.

HEIGHT 31 in. **LENGTH** 27 in.

WEIGHT PER HORSE 6 lb.

Like the Kobalt sawhorse, Stanley's fold-flat horses are made entirely of plastic. I worried both would be flimsy, but each set held a large stack of wet pressure-treated lumber with no ill effects. Each horse has six hooks—four for hanging tools and two down-facing hooks for wrapping cords—but none are big enough to be of much use. My worm drive's handle doesn't fit over the tool hooks, for example.

WORX WX065

PRICE $70 **WEIGHT RATING** 1000 lb.

HEIGHT 32 in. **LENGTH** 27 in.

WEIGHT PER HORSE 8 lb. (with clamp)

Sometimes things look better online than they do in person. The big selling point with these horses is the quick-adjusting bar clamp on the top rail. The two halves of the horse lock the clamps in place when you fully open the horse—which means they also fall off when you fold the horse. The clamps are flimsy and the mechanism gets bound when they're attached. Except for the clamps, these are similar to the Kobalt and Stanley horses, but cost $30 more per pair.

KOBALT 81330

PRICE $80

WEIGHT RATING 2200 lb.

HEIGHT 26-32 in. **LENGTH** 42 in.

FOLDED DIMENSIONS: 3x6x36 in.

WEIGHT PER HORSE 21 lb.

Remodeler Andrew Grace wrote about these horses in *FHB* #280. They have a predrilled top and height-adjustable legs, and notches on the ends receive 2x stock. They get smaller when folded than similarly designed horses in the test, but you have to fold the fully collapsed legs in the right order or they won't fit inside the housing.

STANLEY STST11154

PRICE $40

WEIGHT RATING 1000 lb.

HEIGHT 29 in. **LENGTH** 31 in.

FOLDED DIMENSIONS: 4x4x31 in.

WEIGHT PER HORSE 6 lb.

If I were a carpenter traveling by mass transit, these are the sawhorses I would carry. They weigh less than any other in the test and have a minimalist design Krenov would approve of. The top is not pre-drilled and the short legs are not height-adjustable, but you can lock a pair together and carry them one-handed. But stay away if you're tough on gear.

TOUGHBUILT C650

PRICE $80

WEIGHT RATING 2600 lb.

HEIGHT 25-32 in. **LENGTH** 43 in.

FOLDED DIMENSIONS: 4x6x43 in.

WEIGHT PER HORSE 20 lb.

These are biggest and heaviest horses in the test. The top has notches on the ends that receive 2x stock and is predrilled for a sacrificial top. The telescopic legs adjust independently. You have to fold them into the housing in the right order, and two of the legs must be lowered, but the other two can be kept locked in at your preferred height.

SHOW US YOUR STALLIONS

When preparing for this feature, I used the *FHB* podcast, social media, and FineHomebuilding.com to ask for ask for input on the best sawhorse features. We received so many homemade sawhorse designs, it was too much for one article, so we decided to cover those versions in the future. Magazine readers, we want to hear from you too—email some photos of your favorite shop- or site-built sawhorses to fh@taunton.com.

—P.M.

A Better Way to Build Tall Walls

This method of balloon framing makes constructing gable walls both safe and efficient

BY TIM UHLER

Visit the site of almost any new house going up in the United States, and chances are it's being built using a method known as "platform framing." Each story goes up independently, starting with a floor system that forms a so-called "platform." The builders then frame and lift the first-story walls on top of that platform. To add another floor, they simply add another platform, then more walls. There's a lot to like about the method, which is why most home builders—our company, Pioneer Builders Inc., included—use it. But it's not the only way to build.

Over the last decade, we've been incorporating more and more of what is known as "balloon framing" into our new-house builds. This is the original method of light-frame construction, and its most prominent feature is long studs that run unbroken all the way from the bottom of the house to the roof. While platform framing is generally faster and safer, we find balloon framing is an efficient and safe way to build many of our tall walls—especially gable-end walls (aka rake walls). We can frame and sheathe them flat on the ground, build overhangs and soffits, and even install siding and windows before lifting them into place. This cuts down the amount of time we have to spend on ladders, which reduces the chance of falls and the wear and tear on our bodies. Our methods for building these tall walls

Drawings: Christopher Mills

has evolved over time into the process shown here, which incorporates the lessons we've learned along the way.

Details that make a stronger wall

This isn't the classic method of balloon framing, with joists nailed to the sides of studs and supported on a ledger let in to the studs. These are simply tall walls uninterrupted by a floor system, and building this way has advantages beyond efficiency and safety. For one, it can reduce the amount of hardware needed to tie walls together. And on rake walls, the roof sheathing gets nailed into the double top plates at the top of the wall, directly attaching the roof diaphragm to the wall system to provide a significant improvement in performance during high-wind events.

Tall walls may need to be designed for wind loads and must be strong enough to be lifted into place. Usually we have a floor and/or ceiling that attaches to these walls to add rigidity, but we also add extra lumber for stiffness both during the lift and during the life of the wall. With single-story gable walls, that simply means doubling the king studs on either side of openings. If the wall is two stories tall, we often drop the stud spacing down to 12 in. on center, triple the kings, and double the end studs—depending on how much additional support the wall will get from floors and partition walls. For king posts, which support the structural ridge for the roof, I like to order full-length glulam columns if the post is over 10 ft. tall. We'll use 6x6s for shorter king posts, but longer 6x6s tend to have too many defects to work.

Codes require fireblocking at each floor and ceiling. This is handled by the top and bottom plates in platform framing, but has to be installed separately in balloon frames. Nominal 2x material at the same depth as the stud satisfies the code requirement, but I prefer to use 4x6 blocking for this because it stiffens the wall for lifting and it provides larger panel-edge backing for the structural sheathing and additional nailing for floor or ceiling ledgers. I like the tops of these blocks to be flush with the interior partition walls so I can strap the top plates to the blocking.

Our exterior walls are always 2x6, and I order all stud material long enough for the longest stud, and use the cutoffs for window-sills, cripples, and blocking. If more than a couple studs are over 16 ft., I order LSL studs

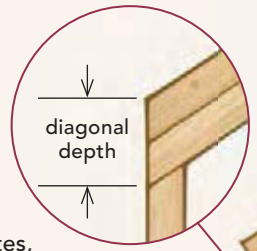
ANATOMY OF A BALLOON-FRAMED WALL

*Dependent on intersecting ceilings, floors, and partition walls

LAYING OUT GABLE ENDS

CALCULATING CORNER STUDS We story-pole corner studs to ensure we account for all the layers in the intersective eave wall, and to check our math when calculating end-stud heights. The formula for these studs is simple:

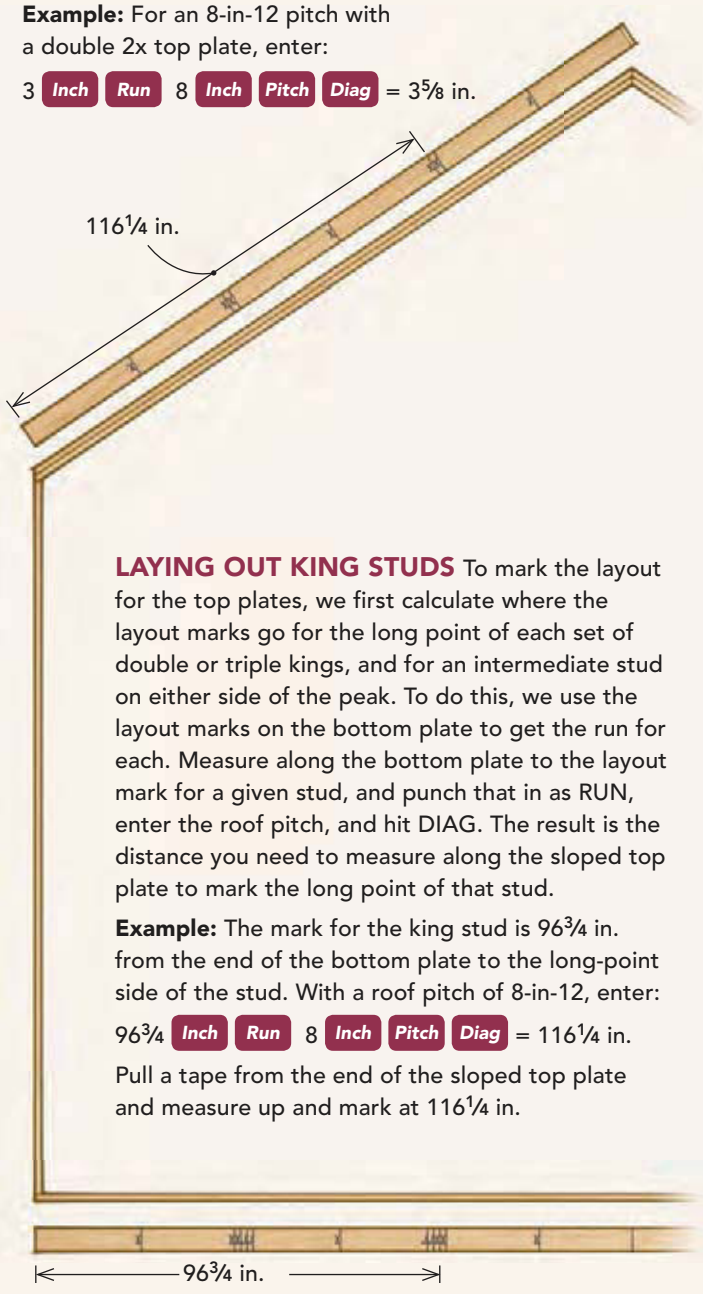
Intersecting eave wall height
+
Height above plate for rafters
−
bottom plate
−
diagonal depth of double top plates



To get the diagonal depth of the double top plates, enter the thickness of the plates (typically 1½ in. each) as the run, enter the roof pitch, and hit DIAG.

Example: For an 8-in-12 pitch with a double 2x top plate, enter:

3 Inch Run 8 Inch Pitch Diag = 3⅝ in.

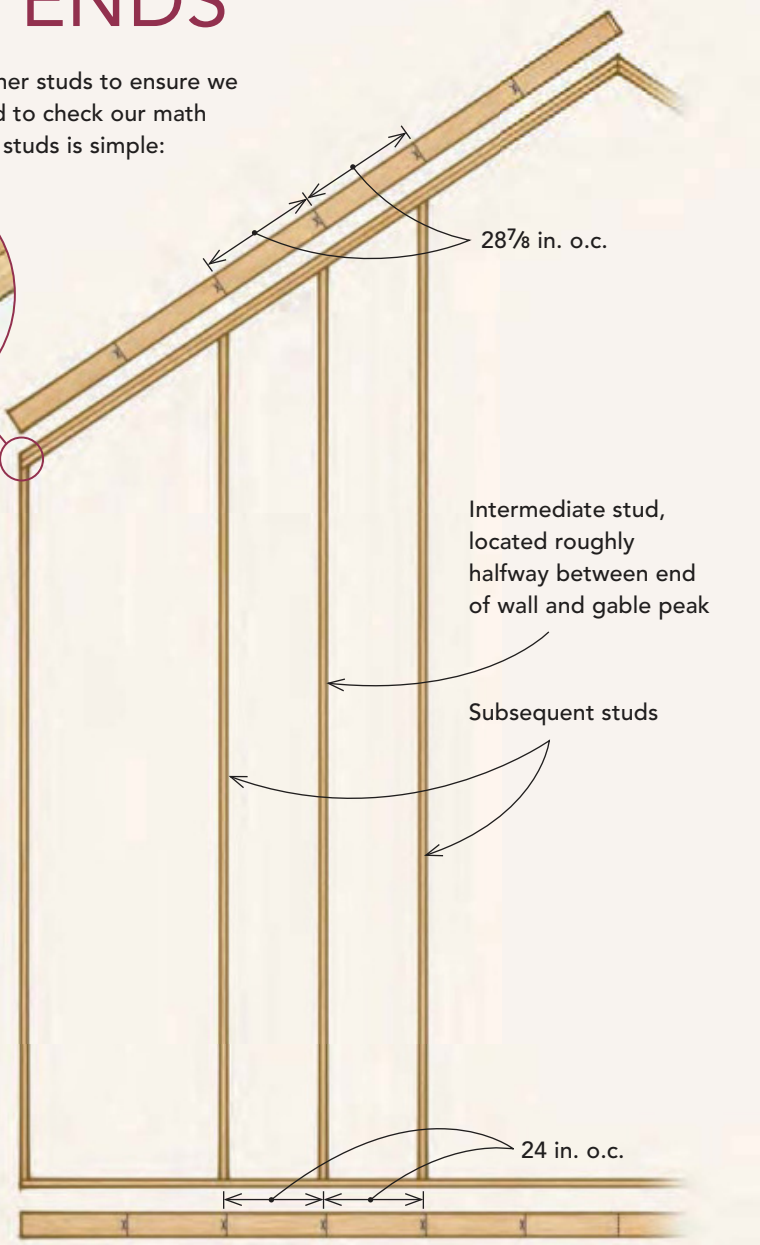


LAYING OUT KING STUDS To mark the layout for the top plates, we first calculate where the layout marks go for the long point of each set of double or triple kings, and for an intermediate stud on either side of the peak. To do this, we use the layout marks on the bottom plate to get the run for each. Measure along the bottom plate to the layout mark for a given stud, and punch that in as RUN, enter the roof pitch, and hit DIAG. The result is the distance you need to measure along the sloped top plate to mark the long point of that stud.

Example: The mark for the king stud is 96¾ in. from the end of the bottom plate to the long-point side of the stud. With a roof pitch of 8-in-12, enter:

96¾ Inch Run 8 Inch Pitch Diag = 116¼ in.

Pull a tape from the end of the sloped top plate and measure up and mark at 116¼ in.



LAYING OUT ON-CENTER STUDS Once an intermediate stud is laid out, we calculate the unit length (the distance between studs along the sloped top plate) between the long points of studs and pull measurements uphill and downhill from the intermediate stud. To get that unit length, simply punch in the on-center spacing of the studs (in our case, usually 24 in.), the roof pitch, and hit DIAG.

Example: 24 Inch Run 8 Inch Pitch Diag = 28⅞ in.

We don't want to simply step these off; to minimize error, we pull a tape uphill and downhill from the intermediate stud's layout mark. So after hitting DIAG, hit STORE, then M+.

To easily add the distance to subsequent layout marks, hit

+ Rcl M+ =

Continue hitting = to get the distance from the intermediate stud to each subsequent stud location.

Made for lifting. *Rather than put the wear and tear of lifting walls on our own bodies, we put it on machines made for the job.*

instead of solid lumber. These cost about double the price of Douglas-fir framing lumber, but are perfectly straight and I can order them in lengths up to 40 ft. Regardless of the material, select the straightest lumber for studs, and oppose the crowns when ganging together king studs or columns.

We typically use 4x10 headers in our eave walls, and we use them in gable walls as well because it's just easier to keep everything consistent. I order 16-ft. 2x6s for all wall plates—I haven't found any advantage to switching to LSLs in order to keep them continuous on long walls. The sheathing ties everything together really well, and the bottom plate gets nailed 6 in. on center through the floor into the rim when the wall is lifted.

Where math meets reality

Our tall walls usually include a gable end. Though I know math is perfect, I am not and neither is most lumber. So rather than calculate all the stud lengths for gable ends, I prefer to lay out the bottom plate, cut the top plates to the same length as the theoretical rafter length for this section of roof, and then use a story pole for the ends of the wall. The story pole includes all of the layers of the intersecting eave wall—plates, studs, joists, and floor sheathing—to ensure I'm accounting for everything when I calculate the end-stud heights. I want the tops of the double top plates even with the tops of the rafters or roof trusses, so I calculate the length for the end studs to run from the bottom plate to the first top plate (see "Laying Out Gable Ends," left). A common rule in framing is that everything grows, so I subtract ⅛ in. from this stud height—it's far easier to pad up if we have to than to plane it down. We nail the skeleton together, square it, and then tack it to the floor.

From there we transfer the layout from the bottom plate to the underside of the top plate. One framer measures along the bottom plate to the uphill side of all kings around openings, enters that as RUN in a construction calculator, punches in the roof PITCH, and just clicks the DIAG button to determine how far up the rake to mark. Once all the openings are laid out, we cut and install an intermediate stud—one about halfway between the gable peak and the end of the wall. I've found that pulling layout uphill and downhill from this stud minimizes any accumulated error, and by doing this on both sides of a gable it allows us to zero-out any error. Even though the calculator will keep

Rig, lift, brace

These walls are made to be lifted by machines, not human strength. We can lift most of these walls with our telehandler, but when we don't have access to position it properly, we hire a crane. I had custom brackets engineered and then fabricated by a certified welder. Made of ⅜-in. steel, each is rated to handle more weight than the heaviest wall we have ever lifted. This is a connection you don't want to fudge—dropping a wall this big could ruin a lot more than your floor system.

Having the hardware and equipment isn't enough—we are also forklift and rigging certified. I wouldn't recommend lifting these heavy walls without this training. The load charts on the machine tell us its lifting capacity at any given length and height of the boom.

We don't do anything but toenail the bottom plate to the floor to prevent kickout. In all these years lifting big walls, we've never had the plates come off as we tilt them up—that can be a concern if the machine is off center due to access. The way we lift minimizes the force on the bottom plate; with a telehandler, we start by lifting up, then retract the boom a bit, and repeat until the wall is upright. Once the wall is halfway up, the machine "sees" less load as the weight distribution shifts toward the bottom plate.

Once the wall is up, we use a laser plumb bob to plumb it and brace it with 2x6s fastened with structural screws. It is especially important to use enough braces and place them in a way that they can stay put until the roof is framed and sheathed. We frame all of the intersecting walls ahead of time so they're ready to drop into place immediately (again, with a machine) to further steady and brace these tall walls.

Modern balloon floor framing

When floor framing gets attached to these tall walls, we hang joists off of ledgers that are attached to the wall using structural screws like FastenMaster FlatLok or Simpson Strong-Drive SDWS Timber screws. The engineer specifies the number and spacing of the screws, which are critical details because this attachment connects the floor diaphragm to the wall. When the ledger is installed, it's easy to check the wall to see how straight it is. Even though it is plumb at the braces, we need to straighten it at the floor system.

track of rounding, it's worth taking the time to get this right.

Once the top plates are marked, we measure all of the full-height studs in place by pulling a tape between the layout marks on the bottom plate and sloped top plate.

Cut and assemble

Our method works very well for two framers. One is responsible for the majority of cutting and the other assembles the pieces. While the former gets going on studs and window packages, the latter cuts headers and starts nailing the pieces together. We always start with the windows because they take up the most room and have the most pieces.

Once the wall is framed, we snap lines for the fireblocking at ceiling heights. We cut and install all the common-length blocks, then piece in the smaller ones. The whole time, we pull a tape and eyeball things to keep the studs straight.

The entire exterior of each of our homes is sheathed in Zip System structural sheathing in order to resist the lateral loads from earthquakes and to provide the water-resistive barrier. To minimize blocking, we always install panels vertically. Although longer lengths are available, I order 8-ft. sheets for better unit pricing and to minimize waste due to odd floor sizes, such as 14-in. joists. Starting the sheathing and blocking layout from the top of the second-floor wall and working down means I can connect the bottom row of sheathing from the blocking to the mudsill.

We cut all openings and the tops of the rakes with a router and a panel pilot bit, which is fast and clean. After the wall is sheathed and nailed, we tape and roll the seams to ensure the tape adheres for an airtight and watertight assembly. At each end of the wall, we tape the Zip sheathing to the outside face of the stud.

Take advantage of easy add-ons

With the wall sheathed and still flat on the deck, we can boost efficiency and job-site safety by adding other elements now, rather than later from ladders, lifts, or staging. Whether it's a gable or an eave, we install nearly all overhangs before lifting the wall. Since the top plates were tacked to the floor straight, our overhangs will be straight. We frame overhangs out of 2x6s with tiebacks every 4 ft. and rely on the 16-ft.-long LP Soffit we use on all our builds to help straighten and stiffen the wall. Then we install the trim.

Setting large windows up high is tough and dangerous, so I also like to install windows before we lift (if they've arrived). We typically don't have windows larger than 6 ft. long, but I'd be comfortable going bigger than that because these walls are stiff enough to squash any worries about the window flexing. We flash the sill, then hang the window with the bottom parallel to the bottom plate and centered in the opening. Then we square the window and fasten it with screws. Later, when the wall is up, we can make minor adjustments if needed and add shims.

If the house is clad in lap siding, we install that as well, because it's easy to install and keep straight with the wall laid down. I like to start the siding about 6 ft. from the bottom, which leaves room for trades to rough-in their through-wall connections and is low enough for us to side up to from the bottom later without ladders (the last row gets tucked under the existing siding and bottom-nailed). We burn 1½ in. below the mudsill, and then mark the top of each course of siding and snap lines. Besides ensuring straight coursing, the lines make it so the installer doesn't have to use a tape to constantly check coursing. We hold the siding back 1 in. from the corners to allow for the tape from the intersecting wall to overlap by 1 in. After the walls are all up and the siding's on, we install cornerboards over the siding to make these joints both durable and low maintenance.

These seem like small things, but they add up to a lot of time savings. Overall, it probably takes half the time to add the overhangs, soffit, windows, and siding with the wall laid flat than it would with the wall standing up. And we can do it all without ever having to climb a ladder or strap on a harness. □

Tim Uhler is a lead carpenter with Pioneer Builders in Port Orchard, Wash. Photos by the author.

Make Your **Mark**

A look at the best marking tools for a wide variety of building materials and applications

BY JUSTIN FINK

There's an old saying that a good carpenter never blames his tools. Well, whoever said that clearly never tried to mark accurate joinery work with a soft pencil, or lay out plates with a brittle lead, or write on wet lumber with either. Some carpenters may take pride in the fact that they use the same carpenter's pencil for every task, but I'm a little different. I take comfort in knowing that whatever I might encounter on the job site, I have the right marking tool in my arsenal. There's a whole wide world of options beyond the carpenter's pencils and Sharpies many tradespeople limit themselves to, and it's a world worth looking into. □

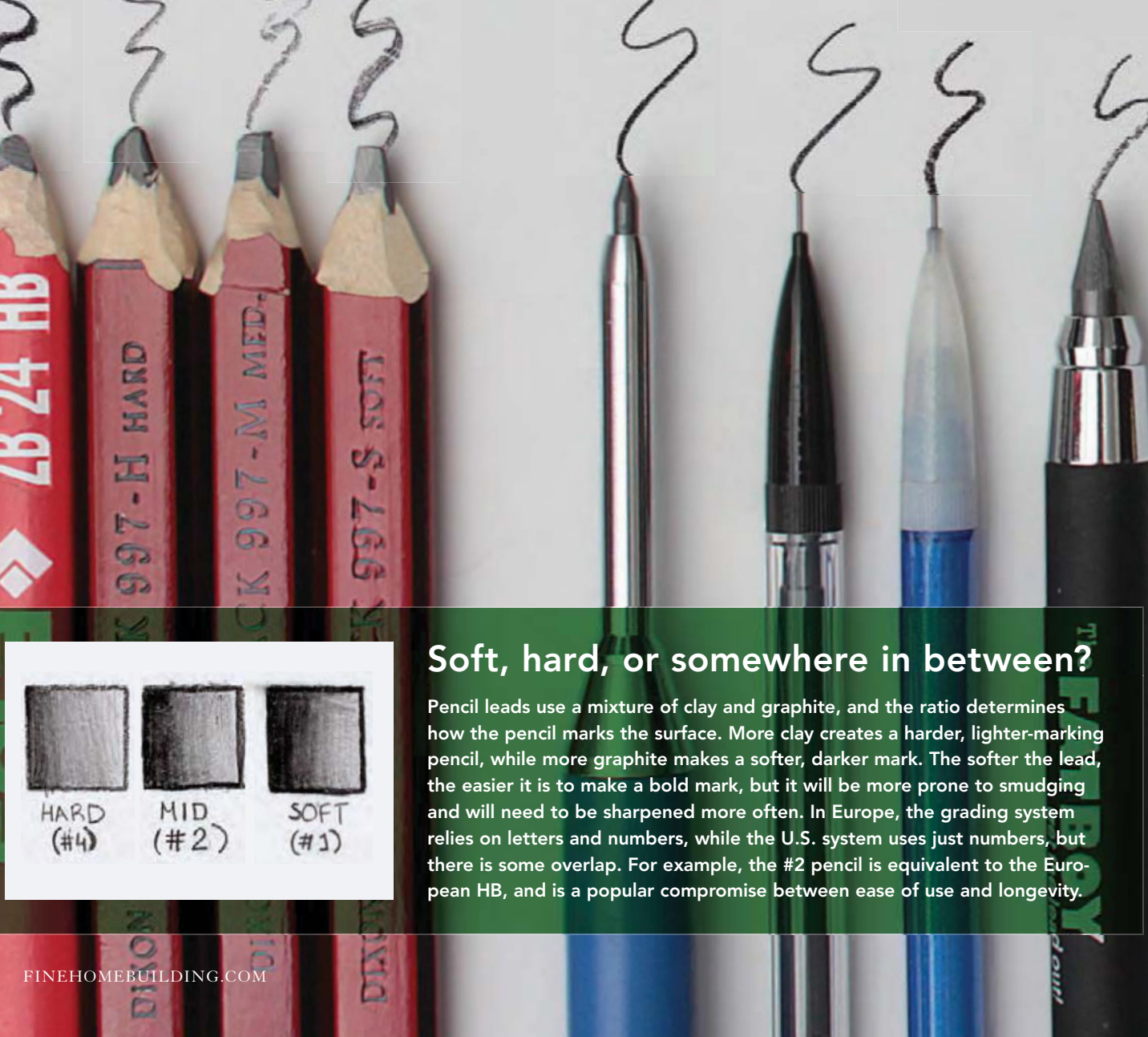
Justin Fink is builder-at-large. Photos by Melinda Sonido.

CARPENTER'S PENCILS

Carpenter's pencils are a perfect example of form following function. Their wide, flat cross sections make them equally easy to grab in a normal writing grip or grasp in the palm in line with the pointer finger, which is common when marking framing layouts. The large lead—available in soft, medium, and hard—is also rectangular in cross section, making it ideal for both thin and wide lines. And of course, a flat pencil can't roll away, or off the edge of a scaffold or roof deck. The flat faces of the pencil also make it an ideal shim or scribing block in a pinch. European-style carpenter's pencils are also available, and come in extra-long lengths.

MECHANICAL PENCILS

Always in need of a sharp point, many finish carpenters have relied on the refillable lead of mechanical pencils to avoid the need to stop and sharpen during work. The catch, of course, is that the thinner the lead, the more likely it is to break in use. Lead sizes are measured in millimeters, and can be found down to 0.20 mm in art supply stores, but 0.7 mm is about as thin as is feasible for a tradesperson—even that will likely break often during use. Leads sized 0.9 mm and larger are favored for their balance of accuracy and durability. Much larger leads are also available. Heavier-duty 2.8-mm pencils (around $15 to $20 apiece), often called "dry markers," feature a deep-reach design—ideal for reaching into recesses to make marks—and some come with plastic holsters. Wider leads, like those found in the Fastcap FatBoy pencil shown below ($18), can be used with a regular sharpener.



Soft, hard, or somewhere in between?

Pencil leads use a mixture of clay and graphite, and the ratio determines how the pencil marks the surface. More clay creates a harder, lighter-marking pencil, while more graphite makes a softer, darker mark. The softer the lead, the easier it is to make a bold mark, but it will be more prone to smudging and will need to be sharpened more often. In Europe, the grading system relies on letters and numbers, while the U.S. system uses just numbers, but there is some overlap. For example, the #2 pencil is equivalent to the European HB, and is a popular compromise between ease of use and longevity.

PERMANENT MARKERS

For most carpenters, the permanent marker comes into action when a carpenter's pencil can't do the job. Although the felt tip can wear out quickly and doesn't appreciate any sawdust, permanent markers are versatile and cost effective, and I can't imagine not having one in my tool belt. They excel at marking everything from the insulation on electrical cables to the waxy surface of an LVL, and are available in a variety of different-sized points so you can match the precision of the task to the right-size marker. Although black ink is by far the most common, don't overlook the utility of other colors. Silver and gold Sharpies, for example, are ideal for marking dark surfaces like asphalt shingles, self-adhered flashing membrane, and felt paper.

RAILROAD CHALK

Although similar in appearance to sidewalk chalk, railroad chalk is softer and creamier in consistency. Its specialty is bold, highly visible markings—it was originally used by railroad workers to mark routing information on the sides of boxcars. On job sites, railroad chalk is useful for making large signs; highlighting areas where caution is needed; marking up concrete for layout, cuts, or trenching; and other rough work where a wide scrawl is acceptable. To me, its biggest benefit compared to something like a lumber crayon or paint stick is that its marks can be removed easily, making something like working out a plumbing layout on a subfloor or slab a more forgiving task. Because of its relative softness, railroad chalk tends to transfer to your hands, so it's worth picking up a purpose-made holder. Railroad chalk comes in a lot of colors, but you won't find especially dark ones or black.

A forgiving formulation. *Leaving a brighter, bolder mark than sidewalk chalk, but still relatively easy to remove from most surfaces, railroad chalk is the go-to for roughing out potential layouts or marking concrete and asphalt.*

WAX PENCILS

The best by far for glass. *Wax pencils make clear marks on glass that are durable but also easily removed with solvent.*

These pencils are sometimes called "grease pencils" or "china markers," the latter name stemming from their use to mark the hard, glossy surface of fine china. Wax pencils will leave a clear, durable mark on glass, metal, rubber, plastic, coated cardboard, and just about any other surface that's smooth. The marks are waterproof, won't dent or damage the surface being marked, and can be removed with a rag and solvent. The classic variety of these pencils includes a wax core with a string running along it that's wrapped in paper. As the core wears down from use, the paper is peeled back to reveal fresh wax. Mechanical versions are far easier to use, though, and cost about the same. In general, wax pencils can be purchased in all the standard colors of the rainbow for about $1 apiece.

LUMBER CRAYONS

Sometimes referred to as a "keel," the lumber crayon is the sidekick to the carpenter's pencil, used when precision is less crucial, the writing surface is rough or wet, or the marks need to be more visible. Lumber crayons are made from wax or clay mixed with ground pigments, and can be found in lots of colors (one company, Amark, sells 24 different hues), but red, blue, yellow, and black are the most commonly available and popular. One of the perks of a crayon compared to a permanent marker or paint stick is that sawdust and dirt won't stick to the tip. On the flip side, temperature will have a greater effect on a crayon than other marking tools, which is why some manufacturers offer crayons in a variety of formulations. The relative softness and hardness of the wax and clay will make a big difference in the feel and finished markings, and also what surfaces the crayon marks will stick to. (Hint: The more clay, the better it marks.) Expect to pay about $1 to $2 apiece, depending on brand and level of quality.

SOLID-PAINT MARKERS

Unlike regular paint markers, which have a reservoir of liquid paint, solid-paint markers are sort of like writing with a big lipstick. They will leave their mark on virtually any surface, making them the most versatile option you can keep in your arsenal, and once dry, those marks are permanent. Some can be wiped off with solvents while they're still wet, but after a few minutes they won't wash off or fade in the sunlight. They're soft in consistency, similar to a glue stick, so they're quickly spent when marking rough surfaces, and although they will mark rusty and dirty surfaces, you can expect them to pick up some debris in the process. Solid-paint markers are most typically seen in jumbo versions—the kind of tool you'd choose for big letters, numbers, and layout marks—but you can also get relatively finer-tipped versions, and any of them can also be shaved with a utility knife to create a sharp point.

MARKING KNIVES

When you scribe a razor-thin line into the surface of a piece of wood with a sharp, metal marking knife, you make it easier to register a chisel for a mortise, or make a saw cut without risk of tearing out the grain. These knives come in a lot of shapes and sizes, but the best ones have a beveled cutting edge backed up by a flat face. This allows the back of the marking knife to ride on a reference surface—a piece of wood or a combination square, for instance—with the bevel on the waste side of the cutline.

INVERTED SPRAY PAINT

No collection of contractor marking tools is complete without a couple cans of inverted spray paint. Specially designed to spray in an upside-down position and sold in a variety of bright colors, these cans of spray paint are the best option for outdoor markings, especially on rough surfaces or dirt. They're also handy for interior work, especially marking trench cuts on a slab or plumbing drain locations, or transferring stud locations to the subfloor before the drywall is installed. Expect to pay about $6 per can. Also, a new discovery for me is spray chalk paint. It operates the same way as inverted spray paint, but shoots liquid chalk, which can be removed with water.

Working With ZIP

There's a lot to like about these insulating panels, and a lot to learn about building with them

BY BRIAN PONTOLILO

Paul DeGroot is an architect in Austin, Texas, a market where the norm is to fill stud bays with fiberglass batts, sheathe the house with OSB, install a lumberyard-branded housewrap, and nail the siding directly to the wall. When the budget allows, Paul tries to do a little better by using mineral-wool cavity insulation, a ventilated rainscreen behind the siding, and Huber Engineered Wood's Zip System R-sheathing, which includes a layer of insulation to provide a thermal break and boost his assemblies' R-values.

In Austin, code-minimum insulation is R-19 in the wall cavities or a combination of R-15 in the cavities and R-2 continuous insulation or R-13 plus R-3 continuous insulation. With continuous insulation typically installed outboard of the sheathing, Paul recognizes that the latter are better options from a durability perspective. But he's wary of builders' ability to get the details right when installing exterior rigid foam outside of the sheathing. It just isn't common enough yet.

Because R-sheathing panels have insulation on the inside, in contact with the studs, windows and doors can be installed in plane with the sheathing with no need for the fussy flashing details associated with exterior continuous insulation. That gives Paul some confidence.

Code approvals and caveats

Like many products not specifically mentioned in the code, Zip R-sheathing has gone through technical evaluation by the International Code Council's Evaluation Service to be certified for code compliance. The report on the product, ESR-3373, includes a slew of details to help builders, engineers, and architects incorporate and use it correctly.

Just like the standard versions of Zip sheathing, R-sheathing qualifies as a water-resistive barrier (WRB) and as a suitable air-barrier material to meet air-sealing requirements of the International Residential Code (IRC) so long as the panel seams are taped according to the manufacturer's instructions. It's also an option to meet various continuous insulation requirements.

The report specifies the panels must be installed on wood-framed walls of minimum 2x nominal framing with studs spaced no more than 24 in. on center. The panels can be installed horizontally or vertically. Because the foam layer is slightly larger than the OSB layer it's adhered to and overhangs one long and one short edge, it's self-gapping—installers just need to keep track of which edges are which.

The thickness added by the insulation—and the fact that the structural sheathing doesn't itself contact framing—requires a change from standard nailing practices. Most braced-wall and shear-wall applications require a minimum 1½-in. penetration into framing and require specific framing layout, fasteners, and fastener spacing. Fastening tables are included in the ICC-ES report and are available on Huber's website. In seismic and high-wind zones, there may be further limitations and adjustments for framing materials other than Douglas fir, so read all product literature carefully before installing R-sheathing in these situations.

Photos: middle, Tim Furlong Jr.; facing page right and inset, Rodney Diaz

R-Sheathing

While most installations can be done with common framing tools, builders choosing to use 2½-in.-thick R-12 panels in shear-wall applications may need to size up their nailers to shoot 4-in. nails.

"I'm given the impression by some of the architects I work with that this is being touted as equivalent to, let's say, ½-in. sheathing or 7/16-in. OSB," said structural engineer Jon Cowen. "That's simply not the case."

Cowen explained that while Zip R-sheathing has passed testing to be included in the prescriptive parts of the IRC, it has limited

3-IN-1

STRUCTURAL SHEATHING, CONTINUOUS INSULATION, AND WRB

Zip R-sheathing is a 7/16-in.-thick OSB panel with Huber's resin-impregnated kraft-paper overlay—a Grade D water-resistive barrier (WRB)—on the exterior-facing side of the panel, and a layer of polyisocyanurate insulation laminated to the inside of the panel. The insulation layer is available in four different thicknesses for four different R-values:

R-3.6 PANELS 1 in. thick with ½ in. insulation

R-6.6 PANELS 1½ in. thick with 1 in. insulation

R-9.6 PANELS 2 in. thick with 1½ in. insulation

R-12.6 PANELS 2½ in. thick with 2 in. insulation

The 4-ft.-wide panels are available in 8-ft., 9-ft., and 10-ft. lengths. The WRB is rated for 180 days of exposure before it must be covered with siding. Seams are sealed and flashing details are incorporated with Huber's seam and flashing tapes and/or fluid-applied flashing products.

A UNIQUE VAPOR PROFILE

Zip R-sheathing is an assembly of three materials with three different perm ratings:

1. The polyisocyanurate insulation has a perm rating of less than 1 perm.
2. OSB is rated at 0.75 perms per in. in dry-cup testing, and 2 perms per in. in wet-cup testing, which means that as relative humidity rises, the OSB becomes a bit more vapor-open.
3. The applied WRB has a perm rating between 12 and 14 perms.

Walls sheathed with Zip R-sheathing will have limited outward drying potential through the low-perm insulation. The cavities will need to be able to dry inward. Should the OSB get wet, however, it will readily be able to dry to the exterior, through the more vapor-open WRB.

structural use, and there have been areas on homes he has engineered using R-sheathing where it couldn't be used. As an example, Cowen points to shear walls.

"Plywood or OSB shear walls have a height-to-width aspect ratio that is a minimum requirement. So, for the height of your wall, let's say 8 ft., the height-to-width aspect ratio that's allowable for a shear wall made of wood structural panels is three-and-a-half to one," he explained, citing the American Wood Council's recommendation for blocked wood structural panels. "The height-to-width requirement for these R-sheathing panels are much, much greater." In other words, you'll likely need an engineered solution to create shear panels when building with Zip R-sheathing.

Cowen solved these problems by using alternative structural sheathing panels in these areas and taking a different approach to insulating them. Alternative shear-wall strategies also include let-in diagonal bracing or metal strapping, or inset shear panels.

Choose the right R-value

When it comes to choosing the right R-value of Zip R-sheathing for a project, Allen Sealock, Zip System product director at Huber Engineered Woods, said, "I find that this topic is one of the most common areas of confusion. I tend to think that the vapor-retarder requirements represent best practice and a more conservative approach, whereas the energy code only takes into account energy usage and has nothing to do with condensation and moisture protection."

Let's unpack that advice with an example: To meet the prescriptive energy code for wood-framed wall insulation in the 2018 IRC in climate zone 6, you can install R-20 cavity insulation plus R-5 continuous insulation (or the R-6.6 Zip R-sheathing). In this scenario, you'd be required to have a class I or class II interior vapor retarder because you don't have adequate R-value of exterior continuous insulation to keep the sheathing warm and prevent condensation (or in the case of R-sheathing, to keep the interior face of the insulation—the first condensing surface—sufficiently warm).

According to the IRC, if you instead use R-7.5 continuous insulation over 2x4 walls or R-11.25 continuous insulation over 2x6 walls, you can omit the class I or class II interior vapor retarder; your painted drywall likely provides all of the vapor control needed because you have reduced the likelihood of condensation forming within the wall. This wall can now dry inward. To Sealock's point, an assembly without a potential condensing surface is a safer assembly, which is why he recommends following the R-value requirement found in IRC table R702.7.1 on vapor control when choosing the right thickness of R-sheathing for your project.

With R-sheathing, you can use whatever cavity insulation you would like. "It comes down to what R-value you are trying to achieve," Sealock said. "We don't have any limitations on cavity insulation." Product literature does recommend that builders include a ventilated rainscreen when using closed-cell spray foam for cavity insulation—that's good advice no matter what you choose to use in the stud bays.

It's also possible to add additional continuous exterior insulation over Zip R-sheathing. When asked about using rigid foam over the product, Sealock said, "It happens occasionally. What it comes down to is whether you're comfortable with what people often refer to as a 'double vapor barrier.' You would be sandwiching the OSB layer between two layers of low-permeance foam. And depending on which school you're from, some people think that's okay; some people think it's not. I tend to think it's okay when everything else is done properly."

When asked the same question about a wall with vapor-open mineral wool as the exterior continuous insulation, Sealock said, "I wouldn't have a problem with that."

Tips from the job site

Jake Bruton is a high-performance builder in Columbia, Mo. He's been using Zip System products for long enough, and well enough, that he's appeared in their advertising. Bruton offers what may be the most important tip about working with Zip R-sheathing.

"It comes shrink-wrapped. Don't remove all the shrink wrap at once," he said, "just take out two or three sheets at a time."

The reason for working in this way, Bruton explained, is that Huber uses a minimal amount of glue to laminate the insulation to the OSB—specifically, Huber uses polyvinyl alcohol adhesives. Left exposed for even a short period of time, the product will delaminate. "This is not a defect," Bruton said. "The manufacturer knows that once the sheets are fastened to the framing, everything will stay where it's supposed to."

Want the insulation on the outside?

One of the most common criticisms of Zip R-Sheathing is that the insulation is on the wrong side of the OSB. If you agree, but like the idea of a product that integrates the sheathing, water-resistive barrier (WRB), and continuous insulation, you might be interested in OX-IS from Ox Engineered Products. OX-IS combines fibrous structural sheathing on the inside with a layer of polyisocyanurate insulation and a WRB facing the weather.

The structural layer of OX-IS is the company's Thermo-Ply structural sheathing product, which itself is an approved WRB according to Todd Gluski, director of marketing at Ox. Gluski said that the panel is structurally equivalent to 7/16-in. OSB, though nailing schedules may differ. The polyisocyanurate insulation is self-gasketing, said Gluski, and coated with a protective polymer that creates a WRB on the exterior face of the insulation.

OX-IS is available in ½-in., 1-in., and 1½-in.-thick panels with respective R-values of 3, 6, and 9. The panels are 4 ft. wide and are available in 8-ft., 9-ft., and 10-ft. lengths. It is rated at less than 0.3 perms. OX-IS meets the IRC's criteria for a WRB and air barrier when seams are properly taped, as well as the criteria for insulating sheathing.

Gluski said that some other reasons for builders to like OX-IS are its light weight and stable pricing. (Zip System and other OSB products are subject to the ever-changing commodity pricing of OSB.) And finally, when the product is installed with Ox seam and flashing tapes, it holds a 30-year system warranty.

Photo: Rodney Diaz. Drawing: Michael Gellatly.

Bruton also addressed builders' most common concern about working with the product—its squishiness and the potential to overdrive fasteners. His solution is to add a pressure gauge between the air hose and his framing nailer and to have one person responsible for nailing the sheathing. In this way, they don't have to walk back to the compressor each time they need to adjust pressure, which can happen quite often with all of the different materials used for framing today.

Tim Uhler, a framer in Port Orchard, Wash., agrees with Bruton that the product is mostly straightforward to work with. "It's the same install as any plywood panel. It's just slightly heavier and a little thicker," he said. "The only thing as a framer that I had to keep track of is that my outside corners need to lap, [taking into account] the extra thickness of the foam. And inside corners, you need to make that adjustment too." Uhler noted that he thinks it is also important to be particularly careful with layout to minimize waste.

When it comes to the concern of overdriving fasteners, Uhler said, "Try not to go insanely fast, and be picky with your depth control." He explained that because the panel is not only structural, and is also the weather barrier, it's worth slowing down and taking some extra care. It's okay to take out your hammer to finish off a few nails, he said.

Last year, Green Building Advisor published an article about a severely botched Zip R-sheathing job that generated a lot of discussion. The consensus was that the job never should have gone so wrong, and that in addition to using an inline pressure regulator, it's important to follow the manufacturer's instructions, use an appropriate-size compressor for consistent pressure when nailing, consider an after-market flush-nailing collar for your framing gun, and have patience in learning to work with the material.

Bruton recommends using a circular saw instead of a router to keep the dust down when cutting openings in R-sheathing. Uhler's method is to use a track saw: "You just line up the track, set the depth, and then you always have nice clean edges that are perfectly straight—and it doesn't take any longer."

While most exposed foam edges will be covered with tape, the bottom edge is sometimes tricky to figure out how to protect. Bruton uses a double bottom plate. The lower plate is wider by the thickness of the sheathing than the second plate. If he is building a 2x6 wall with 1½-in.-thick sheathing, he uses a 7-in. bottom plate. The sheathing lands on top of the first plate, protecting the exposed insulation, and the face of the sheathing is flush with the leading edge of the first plate, creating a coplanar joint that can be easily taped or sealed with fluid-applied flashing.

Other builders install blocking against the bottom edge of the sheathing, fabricate custom flashing details, or inset the wall so the face of the sheathing is in plane with the foundation wall below.

Wrong-side insulation

Armando Cobo, who designs zero-energy homes for the various climate zones of the southwestern U.S., has worked with Huber as part of an advisory team for Zip System products. "If money is no object, [Zip sheathing] is a perfect product to use," Cobo said. "They have the best tape in the business."

But Cobo said that a sheet of regular OSB and a sheet of ½-in. rigid foam are much more affordable than any Zip products, and that installing the materials separately allows him to decide what he wants to use for a WRB based on the wall assembly, and where he wants to put it. The seams of sheathing and insulation can be staggered, and the insulation is always where he thinks it belongs—outside of the sheathing

Sealock understands why builders feel the insulation is on the wrong side of Zip R-sheathing. "A lot of people get hung up on, 'Oh, the OSB is on the outside and that deviates from Joe Lstiburek's Perfect Wall design,'" he said. "But what we tried to bring is a solution [for] the complexities of detailing—installation of siding and trim and windows through rigid foam. Flashing details [and] all of that is simplified with the addition of the nail base on the exterior."

This is exactly what Paul DeGroot is after. □

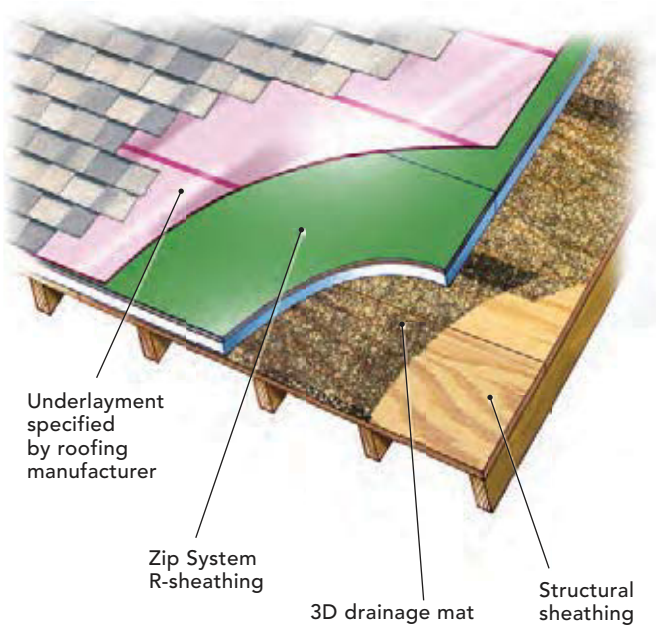
Brian Pontolilo is editorial director of *FHB* and Green Building Advisor.

A questionable solution for roofs

Zip R-sheathing is not approved for use as structural roof sheathing. However, the company recently released a technical document explaining how it could be used as a nail base panel over existing roof sheathing to add R-value to an insulated roof assembly.

The document says, "The panels do not function as a structural panel, underlayment or air barrier for the roof assembly." It describes the need for a drainage space between the structural roof sheathing and the R-sheathing and an additional roofing underlayment, as specified by the roofing manufacturer, on top of the R-sheathing. In this application, R-sheathing is to be screwed to the roof deck and to the framing with "code recognized nail base fasteners," including FastenMaster HeadLok, Simpson Strong-Tie SDWS, and similar structural fasteners.

Allen Sealock, Zip System product director, agreed that this is not likely where this product is going to shine, but said enough builders are asking about using it on roofs that they decided to offer a way to use it in this application. "We're allowing it, but it wouldn't hold the same 30-year warranty, [or] system warranty," he said. It would "only be a manufacturing-defects, basic-commodity warranty" when the product is used as nail base on a roof.



Trim Out a Curved Bay

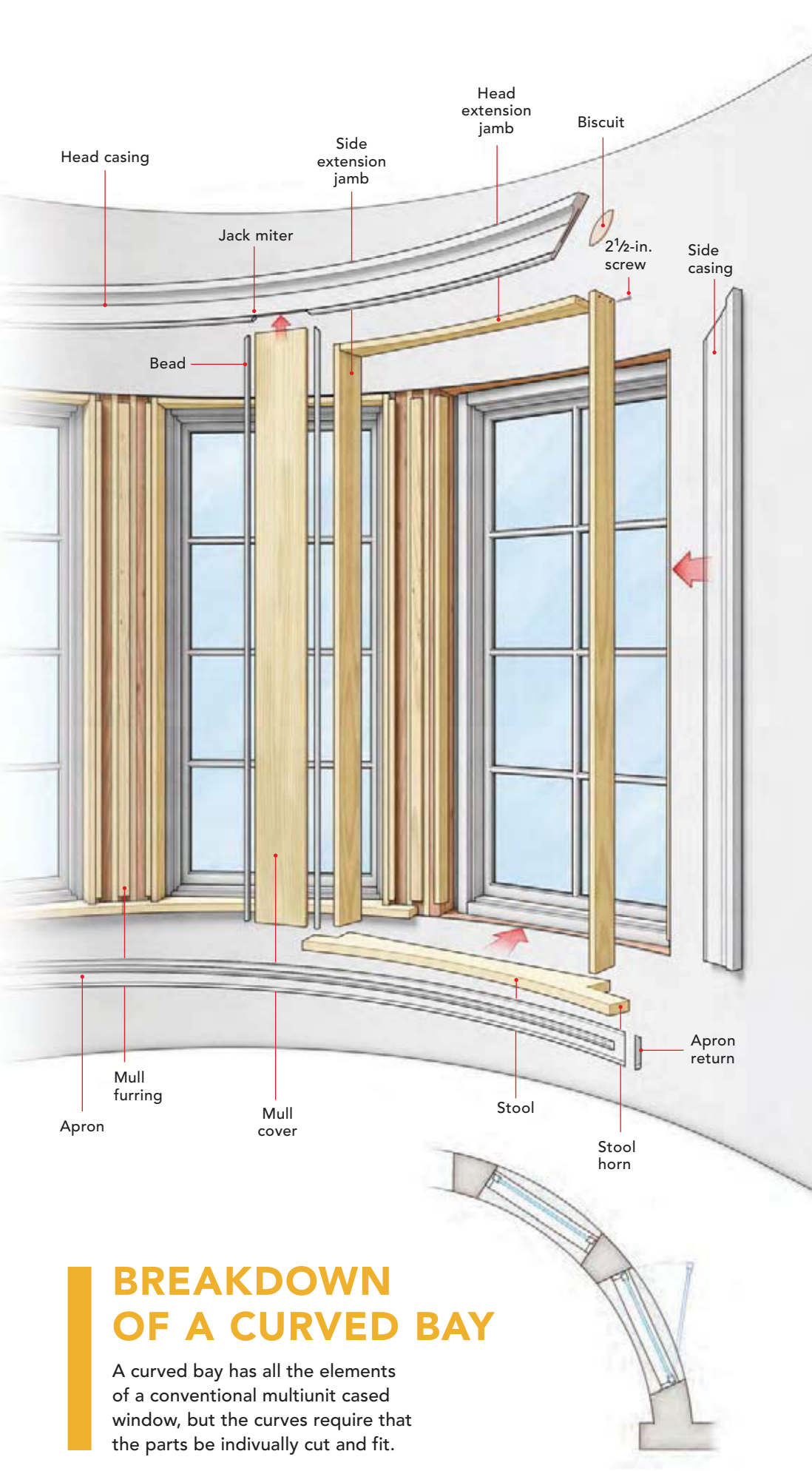
A mix of straight and curved parts brings this round bump-out to the finish line

BY JOSEPH LASKEY

I'm a finish-carpentry subcontractor for Bayview Builders, a custom home builder in Annapolis, Maryland. This affluent suburb of Washington, D.C., provides plenty of interesting carpentry projects for me to work on. Recently I had to trim out a series of casement windows in a round bump-out for a luxury master bath. The windows, which surround a soaking tub, were trimmed with mitered casing and a traditional stool and apron.

A project like this requires patience, attention to detail, and a good millwork supplier. Here we used a mix of materials, some radiused, some square. A custom millwork shop provided the laminated mahogany apron and head casing with the correct radius, but I had to fit and install them. For the stool, we started with square poplar stock, and I rough-cut the curve for these pieces on my bandsaw. To guide that work, I created a template, which I marked with the location of each extension jamb and decorative bead that surrounds the windows.

Photo: Julie Carlisle. Drawing: John Hartman.



In the end, it took a little over three days to finish the job. It was a fun project and I think the finished space is among my favorite in the house. □

Joseph Laskey is a finish carpenter in Crownsville, Md. Photos by Patrick McCombe, except where noted.

BREAKDOWN OF A CURVED BAY

A curved bay has all the elements of a conventional multiunit cased window, but the curves require that the parts be indivually cut and fit.

START WITH THE STOOL

The stool segments, made from 5/4 by 8-in. poplar, are the first component to cut and fit. Each stool segment has one straight side and one curved side. The straight side butts against the casement window frame and the curved side matches the 6-ft. radius of the bay window. The oversize blanks are field-trimmed before the individual segments are joined together and fastened to the framing.

MAKE A TEMPLATE

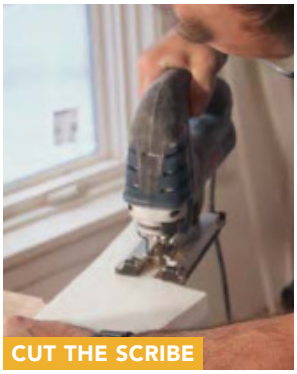
A ¾-in.-thick MDF stool template, used for all five windows, shows the location of casing, mull cover, and decorative bead. A centerpoint on each window is aligned with a centerpoint on the template and, later, each stool blank, ensuring a fair curve.

TRIM THE HORNS

The poplar blanks have oversize horns that need to be trimmed. I align the center marks on the stool and the window to mark the horn length. The two end horns, which receive casing, are longer than the interior horns, which meet in the center of the mull.

SCRIBE THE HORNS

I use an AccuScribe to trace the horns so they match the wall's curve, but a compass would work as well.

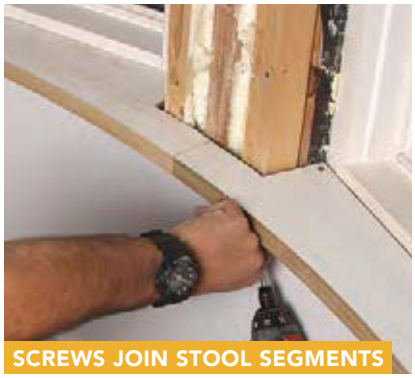


CUT THE SCRIBE

Depending on how much material I have to remove, a jigsaw or hand plane is best for scribing the stool. I sand off any saw marks.

FAIR THE FRONT

The fronts of the band-sawn blanks are trimmed with a router using a 6-ft. trammel arm to ensure a fair curve that matches the radius of the windows. Blocks that stand in for the window opening hold the stool in the right spot, and the cut is made in a few passes so as not to burn up the router.



SCREWS JOIN STOOL SEGMENTS

To prevent gaps from opening where segments butt together, the individual stool segments are joined together using pocket holes and screws placed on the underside of the stool where they will be hidden by the apron.

FASTEN TO THE WALL

Once the segments are joined and leveled with shims, they're screwed to the wall. The screws are driven into counter-bored holes, which are later plugged.

ADD EXTENSION JAMBS

The casement windows require extension jambs to fully conceal the bump-out's 2x6 walls. The reveals for the side extensions are all ¼ in., and I use a laser line to ensure all the extension-jamb tops are at the same height so the casing reveal is consistent.

MARK THE SIDES

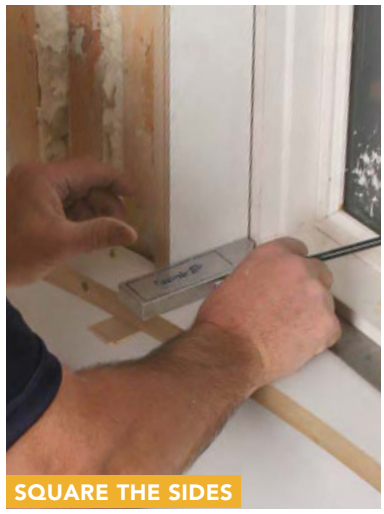
With the extension-jamb side held in position, I mark its length using a laser. The top extension jamb fits between the sides, so I mark the location of its top side on the extension jamb sides.

CURVE THE TOP

The top extension jamb is curved to match the space's 6-ft. radius. The curve is cut using the same setup as the stool, but it's narrower, so ¾-in.-thick scraps, placed on both ends, stand in for the side extension jambs and keep the top centered in the original template.

JOIN THE TOP AND SIDES

The top is connected to the sides with 2½-in. screws driven through the side extension jambs. The holes are made with a Fuller #8 countersinking bit that drills a tapered hole and countersink simultaneously. A try square ensures the top and sides are perpendicular before drilling.



SQUARE THE SIDES

Measure from the center of the window to where the side extension jambs should land, and lightly mark their inside edge on the stool. Then square the extension jamb to the window sash, and mark its full depth on the stool.

FASTEN FROM BELOW

I shim the extension jambs so their exposed sides align with the marks on the stool, and fasten them by nailing from the underside of the stool into the end of the extension jambs with 2-in. 15-ga. nails.

FASTEN THROUGH THE SIDES

A level or straightedge confirms whether the extension jambs are straight along their length. I shim them plumb and then fasten through the sides to the jack studs with 2½-in. 15-ga. nails.

CASING COMES NEXT

The curved head casing and apron are made from hardwood laminations by a specialty millwork shop. They're made oversize and must be field-trimmed. Like anything made from wood laminations, they won't hold a perfect curve for very long after being unclamped from their forms. The parts must be coaxed up and down as they're fastened to keep them perfectly horizontal.

MARK THE REVEALS

A 2½-in.-square piece of ¼-in.-thick plywood glued to the center of a 3-in.-square piece of plywood makes an accurate tool for marking the casing reveal. I move the square along the extension jamb while I hold a pencil tight to the 3-in. plywood's edge.

CUT ONE END

With the end of the casing tight to the miter-saw table, I make a 45° cut on one end of the head casing so it can be joined to the side casing. A curved offcut of the stool blanks (shown right) is placed on the saw's table to help support the stock while it's cut.

TACK IT UP

I align the mitered end with the line marking the reveal for the side casing and then drive a few 1-in. 18-ga. brads to temporarily hold the head casing in position.

MARK FOR JACK MITERS

The head casing has a decorative bead that lines up with decorative beads on the mull covers. I mark where the bead meets the reveal line on the mull, and approximate the angle so I don't get mixed up when I saw.

SWITCH TO THE BACKSIDE

Back at the saw bench, I use my marks on the front and transfer them to the flat backside, which makes it easier to mark and follow with a saw. I mark the 45° angles with a small combination square.

CUT JACKS BY HAND

A Japanese-style pull saw is the easiest and most accurate way I've found to make the angled cuts for the jack miters. I stop cutting as soon as I've gone through the bead on the front side.

CONNECT THE MITERS

I use a jigsaw to remove the bead between the two jack miters. Once the cut is complete, I use a 5-in. orbital sander with 150-grit paper to remove the saw marks.

GLUE THE BISCUITS

After the casing pieces are confirmed correct with a dry fit, I put glue on both sides of the biscuit joint and quickly move the casing in place before nailing. The biscuits prevent gaps from opening in the joints.

FIT, THEN FASTEN

Before installing the first piece of head casing, I make a 90° cut on the end opposite of the miter and make a biscuit slot for joining it to the next piece of head casing. I hold the piece in place to mark the miter and jack-miter locations, cut them, and then dry-fit the piece to ensure the jack miter is correct before gluing the biscuit joint.

BISCUIT MITERS TOO

Biscuits at the mitered corners help align the head and side casing and prevent gaps over the long haul. I also drive three or four extra nails on each side of the miter, about 4 in. apart, which helps prevent the joint from opening.

NAIL THE CASING

The outer edge of the casing is fastened with 2½-in. 15-ga. finish nails about every 10 in. to 12 in. I fasten through the beaded edge with 1¼-in. 18-ga. brads into the extension jambs, and drive the brads through the top of the bead so the holes are easy to fill.

FINISHING TOUCHES

Mull covers made from ¼-in.-thick bending plywood hide the framing between windows. The plywood fits between decorative bead that hides the plywood's edge and ties into the bead on the head and side casing. The final step is to fit a curved apron beneath the stool.

INSTALL BACKING

The edges of the bending plywood need backing for fastening, so I install pieces of 1x stock to the backside of the extension jamb. A pencil line that corresponds with the thickness of the bead shows where to position them. I fasten them by driving 1¼-in. brads through the extension jamb into the backing.

BEAD COMES NEXT

I cut the decorative bead to rough length and then I mark the miter where it meets the jack miter on the head casing. The bottom sits on top of the stool and gets a straight cut.

FASTEN THE BEAD

I run a small bead of glue on the backsides of the bead and fasten the lengths to the extension jambs with 1¼-in. 18-ga. brads about every 8 in.

TRANSFER THE CURVE

I use a small combination square to transfer the stool's curve to the bottom of the mull cover. This will show me how thick to make the furring between the jack studs and the bending plywood. The furring is the secret to a fair curve with the mull covers.

FASTEN THE FURRING

1x stock ripped to match the thickness between the curved reference line and jack studs takes up the space between the bending plywood and the jack studs. Nailing the mull covers tight to the furring is what gives the bending plywood its fair curve.

FASTEN THE MULL COVERS

I use 1-in. brads to fasten the bending plywood along the edges and to the furring in the center. I fasten the center first, and hold the plywood tight to the furring as I nail.

ATTACH SELF RETURNS

The final element, the apron, has self-returns on its ends. The small pieces are cut on the miter saw. I use wood glue on the miter and hold it in place with a pair of 1-in. brads.

ATTACH THE APRON

The apron is nailed to the studs with 2½-in. 15-ga. nails arranged in pairs with one on top of the other. An F-clamp holds the apron tight to the underside of the stool while it's fastened to the studs.

Replacing a Basement Door

Steps for preparing, installing, and flashing long-lasting bulkhead doors

BY MIKE GUERTIN

On this house, the existing basement bulkhead door was its second. The original was made from wood and became too difficult for the elderly owners to lift, so they had this steel one with torsion springs installed in the 1960s. But after 50-plus years of service—and several poor paint jobs—it had rusted through in a few spots and was peeling constantly.

It's not a surprising situation. Sloped basement doors receive a lot of punishment. Children play on them, owners walk on them to reach the wall above, and they're exposed to the elements. They're also close to the ground and prone to damage from lawn equipment such as grass trimmers. Whether site-built out of wood, or manufactured from steel or plastic, they can deteriorate to the point where replacement makes more sense than a repair. □

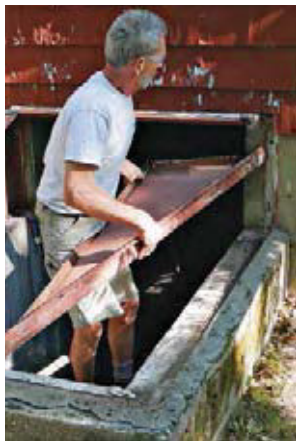
Mike Guertin (@mike_guertin) is editorial advisor. Photos by Colin Russell.

OUT WITH **THE OLD**

Basement doors are most easily removed piece by piece, just as they're assembled. The doors and hardware come off first, then the frame is disassembled and removed in parts.

DOORS AND HARDWARE FIRST
Start by removing the pins or bolts from the hardware to release the doors.

REMOVE FASTENERS
A pry bar often makes quick work of removing the anchors or screws fastening the side panels and sill to the foundation. If a pry bar won't work, a reciprocating saw and metal blade are in order.



DISASSEMBLE THE DOOR FRAME
After unbolting the sill and header sections from the side panels, remove the sill to free the side panels, fold the panels in toward the stair opening until they disengage, and then pry the header piece down from under the siding.

ASSEMBLE THE **NEW DOOR**

To make assembly easier, I unbox the new door components and preassemble them on a flat surface rather than try to do it in place on the foundation.

SET UP FOR SUCCESS
A couple pieces of sheathing are all you need to make a temporary flat work surface to assemble the new door. I use clamps as a second set of hands to hold the side panels upright.

SEAL THE CONNECTIONS
At the header, apply high-quality, clear exterior sealant (I used OSI Quad Invisible) to the joints on both sides before bringing the parts together.

INSTALL THE HEADER
Position the header piece between the side panels and fasten using the supplied bolts. Then set the sill piece into place and fasten.

PREPARE THE **FOUNDATION**

With the old door removed, this is the chance to address any deficiencies in the concrete foundation. Here, the previous installer had put sloped mortar around the metal door to keep out water, but it actually held water against the steel and led to corrosion, so it needed to be chiseled and ground away.

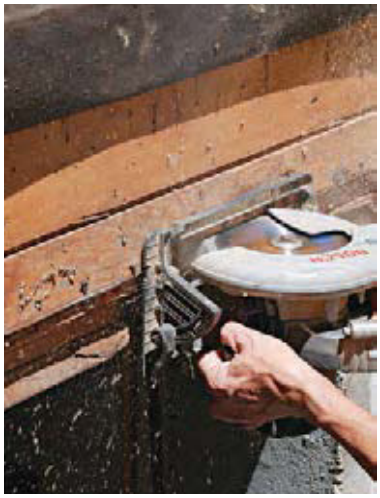
CHECK FOR LEVEL Before installing the new door, use a long level to check the foundation for level in all directions. If needed, apply a concrete resurfacer to level out low areas, or use a grinder to level out high spots.

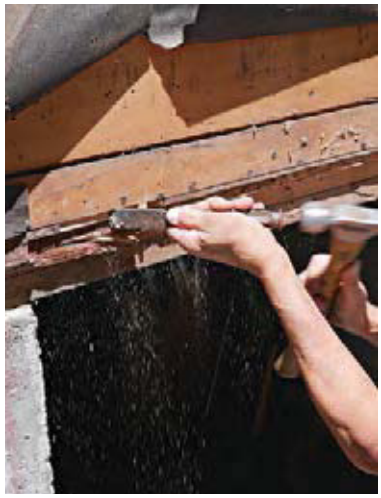
PREPARE **THE WALL**

The new door-frame header and walls need a flat surface to seal against. This means some adjustments may need to be made when the wall sheathing and underlying framing is on a different plane than the exposed foundation wall below. The wall sheathing can be cut back if it's proud of the foundation wall, or pressure-treated furring strips can be installed over the foundation wall to pad it flush with the sheathing above.

REMOVE SIDING
Strip away enough siding from the wall so the door-frame flange can be placed against the sheathing. Here, I removed three courses of cedar shingles to reveal the sheathing and make it easier to slide in replacement shingles after the door is installed.

DRY-FIT THE FRAME Center the frame on the foundation and check the seal against the house. Here the ¾-in. sheathing was about ⅜ in. proud of the concrete, so I traced the flange on the wall for a cutline.

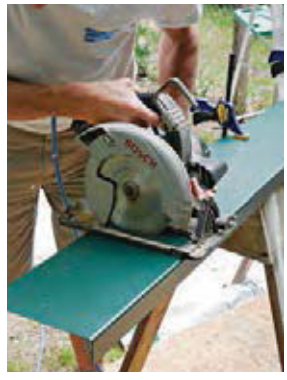


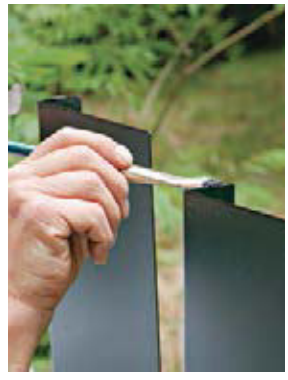


TRIM THE SHEATHING Use a circular saw with the blade set at the depth to be removed to cut along the flange mark, and follow up with a chisel to remove the remaining material to recess the flange.

CAP THE **FOUNDATION**

For a clean, finished appearance, cut and install metal accessory plates over the top of the old foundation walls. Like the door unit, these foundation plates are powder-coated on all sides.



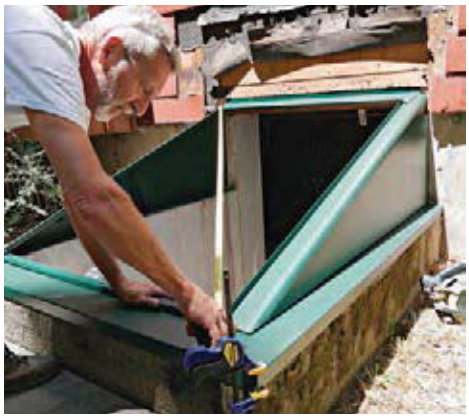


CUT TO FIT I cut the plates with a tungsten carbide metal-cutting blade in a circular saw; an angle grinder with a cutoff wheel can also be used. Prime and paint all cut edges.

INSTALL THE PLATES Apply a thick bead of high-quality sealant to the top of the clean foundation before installing the plates.

INSTALL **THE FRAME**

The most accurate way to locate the mounting holes for the door is to set the door in place, and get it plumb and square.



PLUMB AND SQUARE Dry-fit the door tight against the house and centered on the foundation plates. Measure diagonals to verify that the unit is square, adjusting as necessary.

PREPARE FOR DRILLING Locate and mark the mounting holes on the foundation and walls.

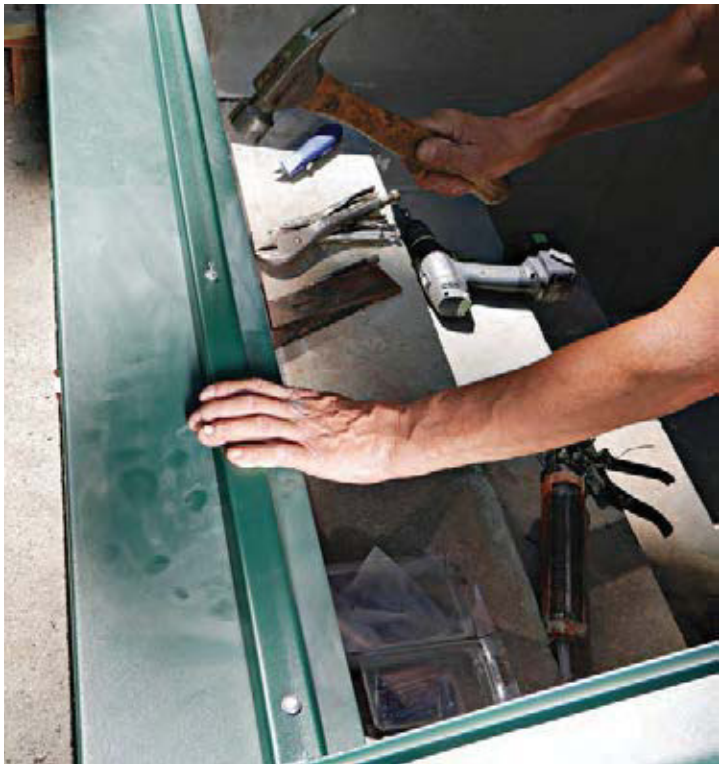
THROUGH THE METAL AND INTO THE MASONRY Start the holes in the foundation plates with a metal-drilling bit, then switch to a masonry drill and bit to finish boring through the thin remaining metal and into the concrete.

POSITION, SHIM, AND SEAL Shim the whole unit about 1 in. above the foundation and apply a bead of sealant along the foundation and walls for the new door frame to bed into.

BED THE FRAME After applying sealant, slide out the shims one at a time and lower the frame, backfilling the areas where the shims were located with sealant.

FLASH THE FLANGE As added insurance against water, install self-adhering flashing tape at the top corners of the door frame where the side panels meet the header flange to help prevent leaks.

FASTEN FRAME TO FOUNDATION To permanently attach the frame to the concrete, install hammer-drive anchors around the entire perimeter.



FLASH AND **FINISH**

With the door in place, complete the installation by flashing the unit to prevent water entry, and installing or replacing the siding.

MANAGE WATER Apply self-adhered flashing tape over the header flange of the door, tucking it beneath the water-resistive barrier on the wall.

SEAL THE UNIT Install manufacturer-supplied weatherstripping around the new door unit.

PATCH THE SIDING Install new shingles above and around the door frame and flange, leaving a ¼-in. space above the header as a capillary break.

HOUSES

ARCHITECTURAL CHALLENGES AND SOLUTIONS

BY DESIGN

CURATED BY KILEY JACQUES

RETROFIT FOR ENERGY PERFORMANCE AND DESIGN IMPACT

At the start of this project, Green Hammer Design Build was brought in simply to repair siding that had failed from moisture issues. The cause was improper flashing, and the shaded site had exacerbated the deterioration of the wet assembly. After discovering the extent of the damage, the homeowners decided the time was right for a deep-energy retrofit. While at it, they wanted to enhance the appearance of the entry. The builder removed the compromised siding and added exterior rigid-foam insulation to the 2x6 walls to beef up their thermal resistance. Special attention was paid to air-sealing, and a rainscreen was added for additional moisture control. Most of the building was re-clad in fiber-cement panels, and the windows were boxed out with sheet metal cut into trim pieces and riveted together. For a layered look on the front facade, the team used recessed rusted-steel panels against brightly colored fiber cement and FSC-certified knotty-cedar siding with woven corners meant to have the look of dovetail joints. Because the steeply pitched, triangular lot does not sit square to the street, the landscape was designed to orient the house to the drive and the road beyond.

Designer/builder Green Hammer Design Build, greenhammer.com
Location Portland, Ore.
Photos Lincoln Barbour, lincolnbarbour.com


2409

OPTIMIZING OCCUPANT COMFORT

Like all projects by Vermont-based New Frameworks Natural Design/Build, this two-story, 1600-sq.-ft. timber-frame home features locally sourced nontoxic products such as blown-in cellulose insulation and lime-casein interior paint. The worker-owned company is committed to the use of natural materials and ecologically sound building practices that incorporate passive solar design strategies. Here, that included glass panels integrated into the porch overhang. They were constructed to take advantage of the low angle of the winter sun, allowing it to penetrate the building and heat the tile floors.

Much of the home's character comes from the many reclaimed and salvaged pieces the homeowners have collected. Among them is an antique soaking tub; it was key to their vision, so the plumber had to determine how best to deliver water to the massive cast-iron receptacle. The tub ended up dictating the sizing of the hot-water system—a pellet boiler with solar hot water supplement—which subsequently drove the decision to add radiant heating. That heating system would not have been a prudent choice otherwise, given the high-performance home's minimal heating loads. The bathroom includes another allowance—the one window on the building's north side.

Designer/builder New Frameworks Natural Design/Build, newframeworks.com
Location Middlesex, Vt.
Photos SB Studio, courtesy of New Frameworks Natural Design/Build

LEARNING TO LIVE IN A PASSIVE HOUSE

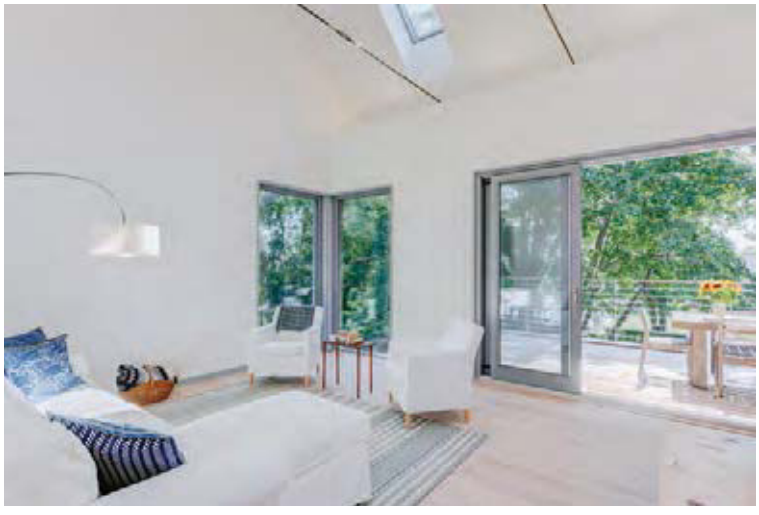
Architect Wayne Turett works primarily in the commercial building sector, so this project—his own house—was a bit of a departure. It was also his first attempt at Passive House certification. Almost two years into occupancy, he is still taking notes on the systems and overall performance.

In hindsight, Turrett says the heat-pump water heater could have been a size larger because of its slow recovery; he has since added a mixing valve to minimize wait time. He also thought the building would have performed a little better than it does in terms of energy usage during the cold months. During warm weather, he has learned, the large window by the side-entry door adds significantly to solar heat gain; he plans to add a Lutron shade to reduce cooling needs. He has also added a motorized damper to control air leakage through the range hood. To optimize ventilation when using the induction cooktop, he feels compelled to crack a window.

There were a few lessons about skilled labor, too. First, he would have preferred to use dense-pack cellulose over fiberglass batts, but he couldn't find a local company to do the installation. Second, a strange odor makes him question the ERV exhaust and supply tubes; he suspects they were installed incorrectly. Turett realized the importance of being able to tap into a skilled labor pool familiar with high-performance products and systems to ensure proper installation and long-term functionality.

Of course, there are many things he loves about the house—notably, the bright interiors. He was pleasantly surprised by how many windows he was able to get into a Passive House design.

Designer The Turett Collaborative, turettarch.com
Builder Vector East, vectoreast.blogspot.com
Location Greenport, N.Y.
Photos Elizabeth Glasgow Studios, courtesy of The Turett Collaborative



"I'm making tweaks all the time because I'm very conscious about how the house operates."

—Wayne Turett, architect

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SPEC

NEW AND NOTABLE PRODUCTS

INDUSTRIAL POP

Inspired by the simple, utilitarian design of early-20th-century warehouse lighting, Rejuvenation's new Carson collection wall sconces strike a nice balance between cost and impact. Each 12-in.-diameter lightweight aluminum fixture sells for $230 and is available in an impressive 25 finishes, ranging from polished copper and nickel to colors both matte and glossy. The standouts in this collection are the bold yellow, green, blue, white, and red glossy enamel finishes, some with a black rim and white underside. All fixtures in the Carson collection are rated for indoor or outdoor use, and can be ordered with an optional, removable cage for an additional $40.

—Justin Fink, builder-at-large

Photos courtesy of the manufacturers, except where noted

STYLISH SELF-STICK WALLPAPER

These luxury self-adhering, removable wall coverings by Mayflower Wallpaper will let you add rich colors and patterns to any room without the mess, fuss, or commitment associated with traditional wallpaper. Mayflower's bespoke, print-on-demand business model allows the company's adventurous duo of designers to offer whimsical patterns inspired by everything from their favorite rock and roll songs to the natural surroundings of their coastal Rhode Island home. Husband-and-wife team Jonathan and Stephanie work with domestic small-batch print shops to make their wallpaper more affordable and sustainable, plus this method of manufacturing enables them to custom-tailor the designs and sizes of orders on request to perfectly match individual customers' needs. With decades of experience making beautiful wallpaper, the company still produces classical patterns on a host of traditional materials, so whatever the style of your home, they're sure to have something to make your next decorating project pop. All of the peel-and-stick papers are 27 in. wide on 9-ft.-long rolls and cost $70 per roll. *—Rob Wotzak, digital brand manager*

HOLLOW RECLAIMED PINE

"Reuse and recycle" is a concept we can all appreciate, and The Olde Mill has taken that eco-friendly mindset to heart when manufacturing their reclaimed architectural beams. Made out of salvaged longleaf pine, these hollow-box lightweight beams are an attractive way to hide framing, ductwork, wiring, and other mechanical systems. The production process includes re-milling old beams into ¼-in.-thick veneers and then laminating them to a plywood substrate, with edges mitered and the surface textured by hand. The hollow beams are all handcrafted in the United States, and are useful for a variety of indoor applications, such as mantels and floating shelves. *—Jessica Chaloux, associate content producer*

IN-WOOD ROT PREVENTER

When repairing architectural elements that have suffered rot damage, the most important step is to address the issue that led to the rot. But sometimes, it's just not possible to eliminate the threat of water. In those cases, Bor-8 Rods are a handy bit of insurance.

Available in a variety of diameters and lengths, Bor-8 rods look like little sticks of cloudy glass. The rods are inserted into holes bored into wood at a prescribed spacing depending on the size of the wood, and are then covered with a treated wooden dowel, wood filler, or caulk before the wood is finished. There they lie in wait until exposed to moisture, at which point the rods diffuse boric acid into the surrounding wood, killing rot fungus before it can cause damage. Bor-8 is safe to use, is environmentally friendly, and effectively controls a variety of wood-boring insects. A 12-pack of ¼-in.-dia., ½-in.-long rods sells for about $20. *—J.F.*

Photo bottom right: Melinda Sonido

"This label sealed the deal on our new home."

NAME: Jesse and Melissa Gallo

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ENERGY STAR

ask the experts

YOUR QUESTIONS—PRO ANSWERS

Which PEX to use?

I'm interested in changing my plumbing to PEX. The previous homeowner made repairs to the home's original galvanized plumbing with copper, CPVC, and PEX. I would really prefer the entire system be the same and intend on doing the work myself. PEX seems like the best option for me, but I don't know which of the three types—a, b, or c—will work best. I'm concerned about chemical leaching, stiffness, and UV light breaking down the pipe.

—NATE FORSYTH
via email

EASY AS 1, 2, 3

PEX tubing used for water distribution comes in three varieties—a, b, and c. PEXa is the most flexible and can be used with "full-flow" fittings. Insert fittings that reduce flow are generally required with PEXb and PEXc.

Max Rohr, academy manager at REHAU, replies: It makes sense that you want to simplify the collage of different plumbing materials in your home. People switch to PEX because it is durable and flexible enough to navigate through tight spaces, reduces the number of required fittings, and, importantly in an occupied house, reduces downtime. PEX is made by crosslinking polyethylene (PE), creating a spiderweb-like structure that is flexible and tough. PE's molecules normally align in parallel strands, like a picket fence. An example is a red Solo cup, which you can rip like a piece of paper from the lip to the bottom once it's cracked. Crosslinking PE changes the molecular structure to look more like a chain-link fence, making it resistant to stress cracking and tearing in all directions.

The difference between PEXa, PEXb, and PEXc is in the way the crosslinking is facilitated during manufacturing. PEX is an extruded product—picture a noodle coming out of a pasta maker. PEXa is crosslinked right as it comes out of the extruder with a high-pressure peroxide reaction, known as the Engel method. PEXb and PEXc are extruded into coils and then crosslinked in secondary steps. PEXb uses either a silane reaction or steam (moisture cure), while PEXc is crosslinked with electron beams. PEXa has the most consistent crosslinking, is most flexible, and has the longest track record in the market.

What should consumers look for in a PEX? The sun breaks down plastics, and PEX is no exception, so look for manufacturers that offer a long warranty against UV breakdown. Typically, an additional layer is manufactured on the pipe to better protect it from UV.

Leaching is a question that comes up regarding PEX a few times a year. Reputable PEX manufacturers obtain NSF/ANSI 61 certification, which is a standard that helps ensure that water-supply piping doesn't add harmful levels of contaminants to drinking water. For more information about this topic and specific examples, I'd encourage you to look at the NSF's "Fact Sheet on the Safety of PEX Plumbing Products," available on NSF International's website.

Deck footings in rocky ground

I'm building a deck where we have a 4-ft.-deep frost line. I might have more rocks than dirt—I've tried digging in several spots and using some specialty footing products without success. I'm curious what you do if you are unable to get below the frost line? I'm about to throw in the towel.

—CHAS THRELKELD
via email

Editorial advisor Mike Guertin replies: My solution is to build a freestanding deck. There is an exemption in the IRC from the requirement for frost-depth footings when a deck is not connected to the house. Freestanding decks only need footings that are 12 in. deep. Design the deck with a beam a couple feet out from the house and a beam along the outside edge, or run the beams perpendicular to the house and the joists parallel to it. You'll no doubt encounter a few immovable rocks even digging shallow footings. I figure if there's a rock big enough that it can't be dug out of a 12-in.-deep hole, the rock itself is deeper than 12 in. Just drill

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Get answers you can trust from the experienced pros at *FHB*. Email your question to Experts@FineHomebuilding.com.

Photo: Charles Bickford

a couple 4-in.-deep holes in the rock, insert short pieces of rebar, then form and pour a concrete footing over the rock and rebar.

Leave a 2-in. space between the deck rim joist along the house side and the house itself, and don't connect the deck to the house. The footings may still heave during the winter when the ground beneath them freezes, but there's no harm when the deck rises and falls a few inches seasonally, as long as any step from inside the house onto the deck doesn't exceed the maximum rise (7¾ in. per the International Residential Code) when the frost melts.

Refinishing old oak

Although my question has to do specifically with 75-year-old oak church pews, there must be a lot of homeowners with old wood trim and similar questions. The original finish was rubbed off over the years, and we'd like to bring back the deep richness of the oak. We did clean the wood to remove dirt and grease and are wondering what to use for refinishing.

—KEN MARGESON
Halifax, N.S., Canada

Mike DiBlasi, of DiBlasi Painting in Millbrook, N.Y., replies: Because the oak is now all cleaned up, the next step is to sand it all to a relatively fine grit of 220. This will help to remove all previous remnants of finish and create a uniform substrate to receive all subsequent finishes. After that, you can stain or dye the wood if you choose.

To bring out the original richness of the wood, I'd go with what was probably the original finish—most likely an oil-based varnish. I'm talking about an alkyd varnish, not a polyurethane, but that could work too. In fact, there are a great variety of products that would work, including polymerized tung oils, wiping varnishes, and water-based finishes, but there are downsides to these. Tung oil may not be available locally. Wiping varnishes (such as Waterlox) take multiple coats to build up a sheen. Water-based finishes dry quickly—sometimes too quickly to get a nice finish on large areas.

Oil-based varnish, by contrast, has a long open time, which makes it easy to blend in the brush strokes. There are plenty to choose from, and they're available in different sheens. The first coat should be thinned approximately 10%. This will seal the wood nicely and dry quickly. Then you simply need to add additional coats, lightly sanding between them, until the aesthetic you desire is achieved. In my experience, two finish coats is usually all you need. As always, read the manufacturer's guidelines on the label.

About the only disadvantage to oil-based varnish is the smell, but that's a problem with any solvent-based finish, and even water-based finishes are not VOC-free. In all cases you should wear an appropriate respirator when finishing.

Removing old insulation

My two-story house has really poor air-sealing and insulation typical of its 1967 vintage. I'd love to vacuum out the insulation, air-seal, vent the rafters, and blow in R-60 insulation. The problem is that there is already 12 in. of loose fiberglass, making air-sealing difficult. I can rent a removal vacuum and bags for about $600. Is this a fool's errand or something a capable DIYer could take on? Can the removed insulation be blown back in? Can I use cellulose, rather than more fiberglass, to bump up the R-value? Also, I'm certain the walls in this house leak like a sieve. Are there any practical strategies and low-hanging fruit for improving air-sealing at the walls?

—SCOTT CURRINGTON
Ann Arbor, Mich.

Jon Riley, of Casco Bay Insulation in Portland, Maine, replies: In general, I support homeowners taking on the dirty job of attic-insulation removal. It will save a whole bunch of money. However, there are a few important details to consider before signing yourself (and your family) up for this adventure.

Most people see fiberglass as innocuous, but considering the mouse leavings, roofing debris, and formaldehyde binders, you're removing a toxic mess. Wear a protective suit and full-face respirator. Further, always be on the lookout for asbestos and vermiculite. If found, leave that to the professionals.

Can you take the heat? An attic is a strenuous environment, especially in the summer. Heat stroke is real and it can sneak up on anyone. Plan your day with achievable, realistic goals; set up ventilation; drink lots of water; and know when to quit. The disappointment of an incomplete project is small compared to your foot slipping off a joist and destroying a ceiling because you pushed it too far. Been there, done that!

Using a professional insulation vacuum requires planning so you don't acciden-

Loose-fill, reuse-fill. *Removing or relocating insulation in an attic is hot, dirty work. Loose-fill insulation can be vacuumed out, but this used insulation can't be blown back in without risk of damage to the machine. If you want to reuse loose-fill insulation, relocating it in the space and moving it back after other work is completed can be a better option.*

Photo: Brian McAward

tally install a thin layer of fiberglass dust throughout your home. Full containment of the room where the attic hatch is located with a zippered dust barrier is the only way to go. Operating the vacuum is relatively easy and relatively dangerous. The steel impeller spins at a gazillion rpm and will easily shoot a knot of wood through the vac bag and a neighbor's window. We typically set up the collection bag facing into an empty box truck. You should point it toward the woods or a windowless wall.

Someone always needs to be with the machine, monitoring the integrity of the bag and how full it is. The bags can weigh a few hundred pounds once full, so make sure you have a way to get it into the truck before you turn on the machine. Don't forget to add up the disposal time and the dump fees when considering whether to do this yourself.

Do the soffit and ridge venting before the attic is a moonscape of insulation. There are potentially big condensation consequences if it gets put off. Gable-end vents are also an option if eave and ridge vents aren't possible. Use spray foam to air-seal all the cracks and holes in the upper ceiling plane before turning to insulating.

Don't blow the old insulation back in. It only takes one small, hard piece of debris to damage an insulation machine. Further, it's fiberglass, which performs poorly compared to cellulose. Make sure to install 18 in. of material so that once it settles you still have R-60. Plan on 2 in. of settling in an open-blow scenario like yours.

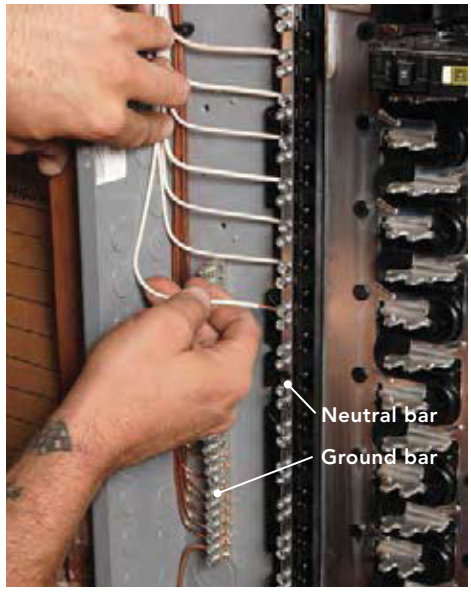
When insulating, if you see the top of an open wall bay from the attic, stick a hose down there and pack it as best you can. Once full, block it off with a piece of rigid foam sealed in place with canned foam for a belt-and-suspenders approach. The air leakage you are experiencing in the living space is directly driven by air leakage in the attic and the basement, creating a stack effect. Sealing up these two areas will slow the air movement considerably and improve comfort throughout the home. The exterior walls are almost always at the bottom of my list, even when they are uninsulated.

Separating grounds and neutrals

I know the electrical code requires the ground and neutral bars in a subpanel to be separate, and for the subpanel to have its own ground rod. I don't understand why, though. Don't the grounds and neutrals all end up going to the same place anyway?

—ANDY ENGEL
Roxbury, Conn.

Cliff Popejoy, a licensed electrical contractor in Sacramento, Calif., replies: Let's start by looking at what the neutral and the ground do in a circuit. Whether it's a feeder circuit supplying a subpanel, or a branch circuit supplying a receptacle outlet, the neutral conductor is the return path for electrical current. Any time a circuit supplies power to a light bulb, tool, or other device, electrical energy flows from the source along a wire (usually black or red in a 120v system) to the thing that uses the energy (the load), and then the electrons return to the source on the neutral wire.



Different wires, different jobs. *Beginning with the 2008 National Electrical Code, residential subpanels are required to be wired with a four-wire feed (two hots, a neutral, and a ground), and the grounds and neutrals must be isolated from one another. Here, they connect to different bars in the subpanel.*

A ground wire, which is better called an "equipment-grounding wire," is there to provide a path from any metal parts of an electrical device that could possibly become energized and pose a shock hazard back to the breaker panel that supplies the circuit, and only carries current if there's a ground fault. These occur when a hot wire—or neutral wire carrying current because the load is on—touches some metal part of the device due to a loose wire or other deficiency. The grounding conductor provides a safe path for the wayward electricity to flow back to the panel to trip the breaker and kill the power. Without the grounding wire, that misdirected electricity could shock you.

At the main service panel, the neutral and grounding wires connect together and to a grounding electrode, such as a metal ground rod, which is there to handle unusual pulses of energy, such as a lightning strike. This is the only point at which the neutral connects to ground. If the neutral and grounding wires are connected together anywhere else, the return current that is meant to flow on the neutral will flow back to the panel on both the neutral and ground. This is dangerous for several reasons; most importantly, if there's a poor connection or break in the grounding wire and the neutral wire, the parts of the grounding system on the far side of the break (from the panel) will be energized and present a shock hazard. This is a big deal, because any exposed metal part of a fixture, tool, or appliance may shock or electrocute you—and breaks or poor connections happen more often than you'd think.

The National Electrical Code (NEC) requirement for separated neutrals and grounding wires in a subpanel and separate neutral and grounding conductors back to the main panel, when both panels are in the same building, dates to the 1999 revision. The requirement for separation of neutral and grounding conductors in and to a subpanel in a separate structure first appeared in the 2008 NEC. Does that make a system with a subpanel with combined neutral and grounding connections unsafe? No, although maintaining separation makes for a safer installation.

Photo: Matthew Millham

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Follow the build: @finehomebuilding and FineHomebuilding.com/fhb-house

BY KILEY JACQUES

Designing for solar panels

It's been interesting to watch the evolution of solar power over the last three decades—so many advances; a few stubborn hurdles. One thing that remains a constant is the importance of the right roof for the job. Too often, it seems, solar photovoltaic (PV) arrays are not part of the initial design plan but rather tacked on long after the fact. In his recent article, "Thinking Like a Roofer," Martin Holladay writes, "Most architects lack a roofer's eye. While a roofer delights in the sight of a simple uninterrupted gable, architects entertain flights of fancy: They come up with butterfly roofs, or flat roofs surrounded by parapets and scuppers, or complicated roofs interrupted by multiple valleys and dormers." Therein lies the PV challenge.

According to Bill Brooks of Brooks Engineering, which does engineering consulting work for the solar industry, common problems associated with solar panels include: insufficient conductor ampacity and insulation, excessive voltage drop, unsafe wiring methods, lack of or improper placement of overcurrent protection and disconnect devices, use of unlisted or improper application of listed equipment (e.g., AC in DC use), lack of or improper equipment or system grounding, and unsafe installation and use of batteries.

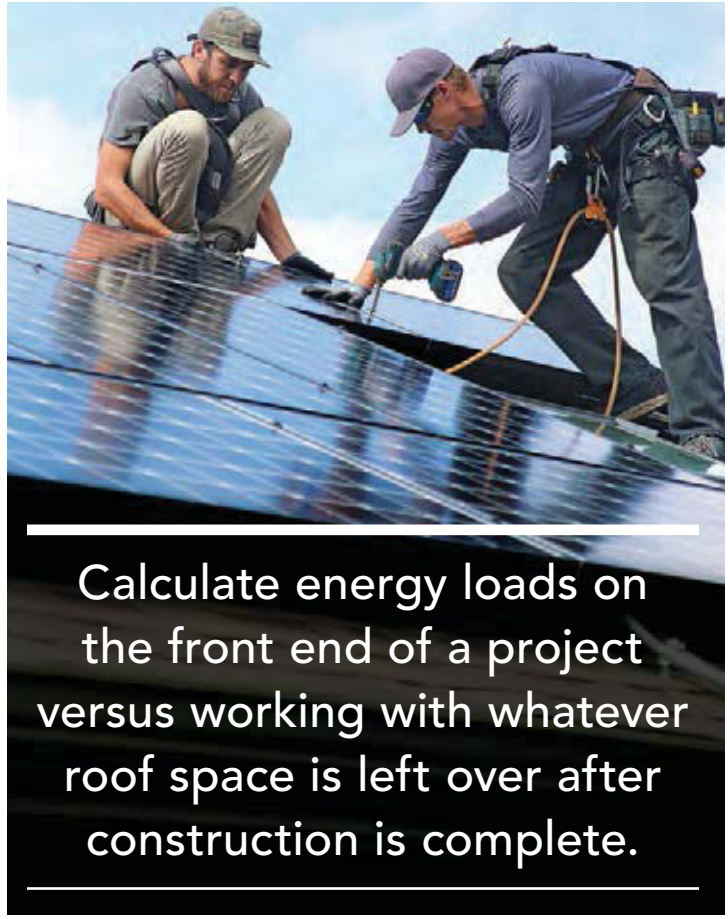
But before all of that, there's the roof itself.

Design drivers

The roofs of many houses are too small, or at least don't have enough uninterrupted surface, to hold an array sized to supply 100% of the electricity the home needs. According to the team at ReVision Energy, a renewable-energy contractor that serves parts of New England, it takes about 75 sq. ft. of roof space for every 1kw of output from a solar array, and about 5kw of output is required to supply all the electrical needs of the average home in their service area. That translates to about 375 sq. ft. of roof space needed to mount an array of sufficient size to meet all of the home's needs.

Many homeowners approach the sizing of a new PV array based on budget. With that in mind, the strategic architect will steer clients in the direction of energy-efficient appliances as the starting point, as it is generally cheaper to install efficient appliances and a small PV array than it is to go with conventional appliances and a larger array sized to handle those electrical loads. Of course, heating and cooling loads, plug loads, and the domestic hot water system need to be hammered out before designing for a PV array.

The price of solar panels has come down considerably over the last decade, and now hovers somewhere between $3.18 to $3.34 per watt, including installation and other fees. Myriad factors can make those numbers go up or down; regardless, factoring solar panels into the roof design has cost-savings potential.



Calculate energy loads on the front end of a project versus working with whatever roof space is left over after construction is complete.

"It's frustrating when providing a good solar roof is an afterthought," says solar design specialist Thomas Tutor of ReVision Energy, "especially when there are plans from the beginning for a home to be net-zero." Tutor advises designing an uninterrupted south-facing rectangular space devoid of dormers, vent pipes, chimneys, or other obstructions. It should match the geometry of the panels to allow for one clean plane with few gaps and little exposed roof. Once you start breaking up the array and spreading panels around, the system becomes less efficient, more expensive, and visually disruptive.

The optimal pitch for a PV array is the same as the location's latitude, though in general, Tutor says anywhere from 20° to 45° is a good pitch. While arrays typically produce more electricity in the summer due

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to the longer days, this output can be boosted further in those months on flatter-pitched roofs, since the sun is higher in the sky. That isn't optimal for winter electricity production, but in markets that have net-metering, which provides credit for excess energy generation, PV users can bank the credits to use in the colder months.

In addition to pitch, two other factors affect solar performance: orientation and shade. Orienting the panels to face south—180°—is optimal, though plus or minus a few degrees of that is still very good, as you are losing just a few percentage points of production. But if the panels are in the shade, their pitch and orientation won't matter much.

"Many people are focused on the tilt and orientation," Tutor notes, "but the reality is, if you have a shade-free roof, then solar is going to be a good investment no matter the tilt and orientation."

Potential obstacles to optimal solar design also include vent pipes, which are not commonly drawn on new construction plans, so when plumbers come on board, they follow the path of least resistance, putting vent pipes wherever that might be. Sometimes that's on the south-facing roof.

"It's always disappointing when our team gets to the site to install the system and finds obstructions in the solar roof," says Tutor. "It means we need to redesign that system and it usually loses some output and performance."

Simple is sage

Ann Edminster, founder of the consultancy Design AVEnues and a leading international expert on zero-energy homes, describes the roof as "an interesting element for architects," noting how it gets manipulated to "create interest." The problem, of course, is that those manipulations have implications. The introduction of additional corners, plane changes, angles, and difficult details drives up costs and results in thermal- and moisture-control-related compromises. "My biggest message is to simplify," she says, adding that designers should start with the end in mind. Factors such as a supertight building envelope and energy-efficient appliances that make it easiest to achieve net-zero-energy performance need to be included in the early stages of a solar design. Like Tutor, Edminster makes the point that people get hung up on the idea of net-zero. "I think close is great—it's not a sin if you don't make it to zero."

> "The roofs of many houses are too small, or at least don't have enough uninterrupted surface, to hold an array sized to supply 100% of the electricity the home needs."

Location impacts numbers

Assuming PV-panel systems have the same solar efficiency, the efficacy of a system is directly related to the amount of sun hours a geographical area gets during the year. The amount of solar radiation per day is measured in kilowatt-hours per square meter per day (kwh/m²/day). On average, northern regions of the U.S. get less than 4kwh/m²/day, whereas southern regions receive more than 5.75kwh/m²/day. In the southwest, where the air is dryer and there is less cloud coverage, more solar radiation makes it to the Earth's surface. On a 5000-sq.-ft. house, which is the average size of architect Armando Cobo's projects, he uses a 10kw system—between 30 and 34 3x5 panels—that's at least 450 sq. ft. needed for the panels alone, in addition to space for clearances, which might result in up to a total of 900 sq. ft. needed to accommodate the system.

Codes require clear roof space around panels and pathways up the roof for firefighter access, as well as space between the panels and other roof penetrations or features like skylights and plumbing vents—all of which Cobo accounts for in the design; he also specifies no-vent zones. And like all designers should, he plans around the requirement that panels not be installed in such a way as to reflect onto neighbors' fenestration or cladding.

Roofing material matters

For its energy efficiency, sturdiness, and durability, standing-seam metal is the most compatible roofing material for PV installations. It allows for an array to be mounted to the seams without any roof penetrations, and the clamps used are less expensive than the mounting hardware for an asphalt-shingle roof. However, metal is not always in keeping with the architectural style, and it's expensive.

Asphalt shingles are significantly less expensive, but they require many penetrations—typically one penetration every 4 ft. along the rail system on which the panels are mounted. That increases the likelihood of premature leaks, shortening the life of the roof. Plus, asphalt-shingle roofs have a lifespan of 15 to 20 years, which is shorter than that of most PV systems.

Mounting arrays on clay, slate, and concrete tile roofs is difficult because the materials are brittle and subject to breakage. Plus, in order to properly secure the panels, the installer needs to bolt the feet of the racking equipment directly to the roof, which requires removing the tiles. Cobo prefers to use standing-seam metal roofing where he wants to mount the array, and he will finish the rest of the roof in the chosen tile. He refers to this method as a "strip-and-go" installation.

It seems fair to surmise that all three designers are in favor of preconstruction planning, uncomplicated roof shapes, and solar-compatible roofing materials as key to the cost-efficiency and functionality of a good solar design.

Kiley Jacques is senior editor at Green Building Advisor.

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CELEBRATING PASSION FOR BUILDING

"My advice for other women who may be interested in the trades? If it is your interest and you feel capable and don't mind learning, just dive in and see if it's for you."

CATHERINE AUTIO
MASTER CARPENTER
NEWTON, MASS.

There is something unfortunate about the traditional trajectory for many of the most skilled builders and remodelers among us. They often succumb to the pull of business ownership if it is evident that recognition or reward is only possible through self-employment. Or, they move into project management positions and endure the crush of a new set of responsibilities for the sake of a "better" livelihood. Either option takes them away from what they love most about building and from where they excel. Paul Eldrenkamp, founder of the Massachusetts-based remodeling firm Byggmeister, understands this well. It's precisely why he created the role of Master Carpenter, a position he designed specifically for Catherine Autio.

"I have the best job ever," Catherine says of her position. "I show up to a project where there's a lead and ask what the goals are for the day, and then I work to accomplish them, teaching younger and newer trades along the way." She helped Byggmeister understand that she plays an important role as a highly accomplished staffer with real responsibilities to the business, who influences quality, teaches, and helps improve efficiency by handling demanding work.

Catherine has been a carpenter for the better part of three decades and feels very fortunate for how much support she's received. It's something the industry at large can learn from, not just with regard to inclusion and diversity, but when it comes to honoring talent, skill, and passion.

For true craftsmanship to exist, we need those committed to the craft to be given professional opportunities to immerse themselves in the work they do best. Catherine should not only be considered an inspiration to younger trades, but to other building-business owners as well. — *Rob Yagid, executive director, Keep Craft Alive*

Keep Craft Alive is our campaign celebrating those who have chosen to passionately pursue a career in design, building, and remodeling. Find out more and show your support by visiting **KeepCraftAlive.org**, and use **#KeepCraftAlive** to share your passion for the cause.

Photo: courtesy of Byggmeister

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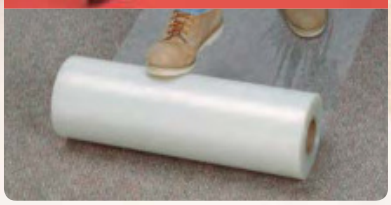

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